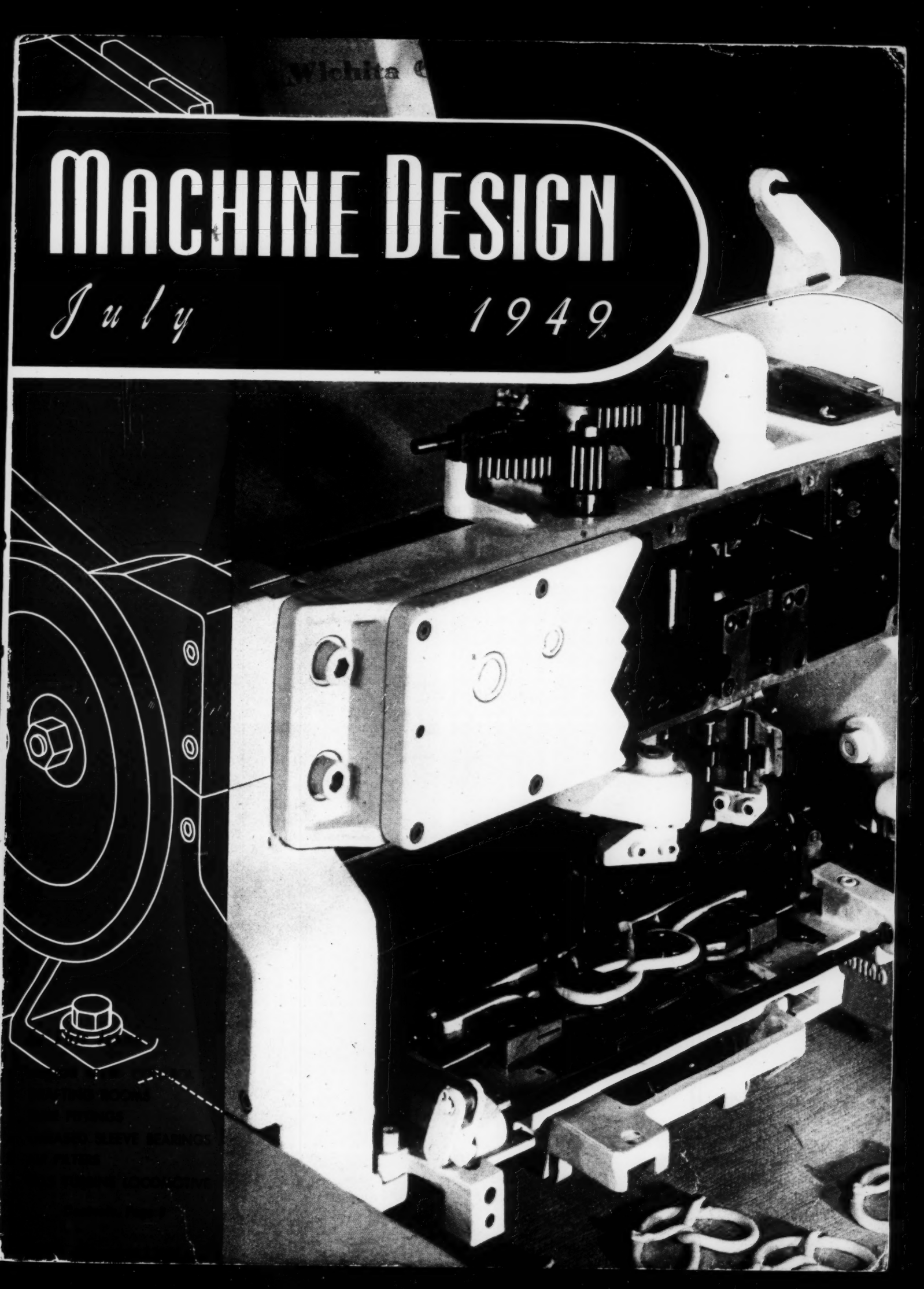
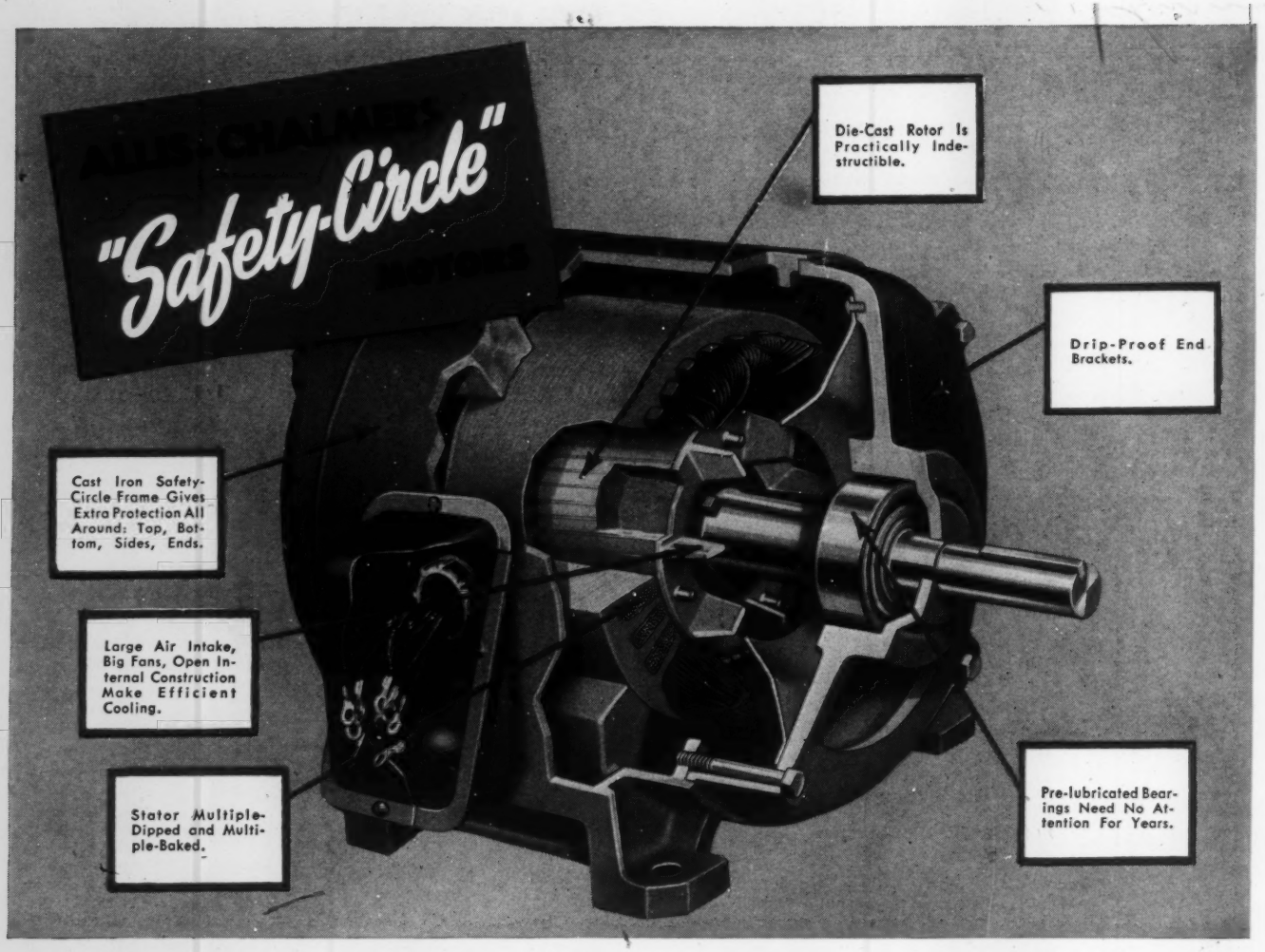
MACHINE DESIGN

July 1949





HOW SAFETY-CIRCLE

Means Motor Dependability

EXTRA PROTECTION means extra dependability. That's why Allis-Chalmers protects the working parts of the motor with the exclusive SAFETY-CIRCLE. Compare this motor with motors of less rigid construction. The SAFETY-CIRCLE motor will not distort in mounting or under strain. And you get the extra protection of drip-proof end brackets at no premium.

EXTRA PROTECTION INSIDE, TOO

Stator is multiple-dipped and multiple-baked in special insulating varnish. Rotor is die-cast aluminum. Stator is mounted in four longitudinal ribs which leaves plenty of air space between stator and frame. Large fans cast integrally with the rotor and ample air intakes keep temperatures well within rated limits. *Ball bearings are factory-lubricated and require no further attention for years.*

When you shop for motors, remember SAFETY-CIRCLE gives you *extra protection, extra dependability* and *lower operating costs.*

For details on SAFETY-CIRCLE advantages, see your A-C Authorized Dealer or Sales Office or write for Bulletin 51B6210B. Sizes 1 to 20 hp, 326 frames and smaller. *Safety-Circle, Texrope* and *Vari-Pitch* are Allis-Chalmers trademarks.

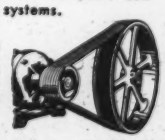
ALLIS-CHALMERS, 1001A SO. 70 ST. MILWAUKEE, WIS. A-2691

ALLIS-CHALMERS

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

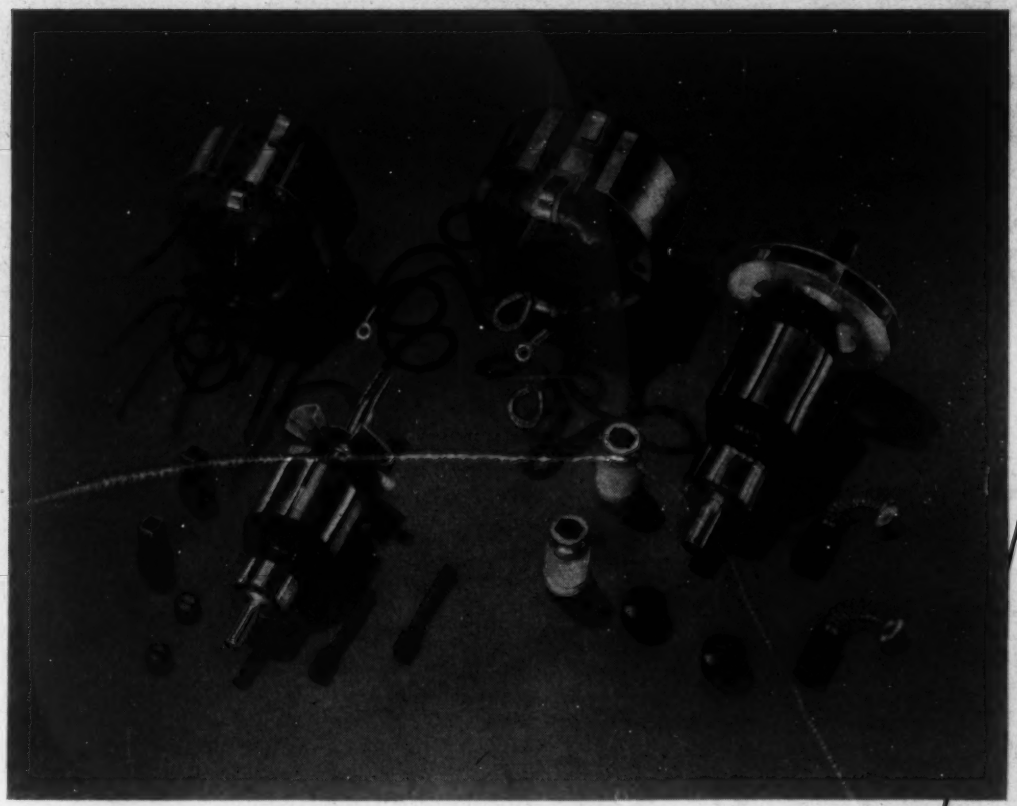
CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.



TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

PUMPS — Integral motor and coupled types. Sizes and ratings to 2500 GPM.

Wichita City Library



Two sizes of Bodine series wound motor parts shown. Maximum output for a given physical size depends on the speed, duty cycle, and effectiveness of the ventilation provided.

Portable Electric Drill Uses

BODINE SERIES WOUND MOTOR PARTS

The basic electrical components of many portable power tools and appliances are dependable Bodine fractional horsepower series wound motor parts.

PARTS. Bodine can supply field coil and core assemblies, armatures, brushes, brush holders, and fans.

SIZES. Diameter sizes up to, and including, 3-11/16 inches. Wound to order for all fractional horsepower ratings.

CONSTRUCTION. Laminations punched from non-aging silicon steel of high permeability ● Insulating material of high dielectric strength ● Magnet wire insulated with vinyl acetal ● Coils thoroughly oven-dried ● Armatures and rotors statically and dynamically balanced ● Long brush and commutator life ● Shafts and armature cores ground to close tolerances.

QUALITY. Nearly a half-century's experience in designing fractional horsepower motors has given Bodine the know-how to provide you with the parts best suited to your particular application. Write, today, for complete information. Bodine Electric Company, 2258 West Ohio Street, Chicago 12, Illinois.

BODINE FRACTIONAL HORSEPOWER MOTORS

DISTRICT AGENTS

BUFFALO 3, N. Y.
Ellicott Square—S. E. Shea

CAMBRIDGE 39, MASS.
686 Massachusetts Ave.—W. A. Block

CLEVELAND 3, OHIO
4500 Euclid Ave.—W. R. Uffelmann

DETROIT 1, MICHIGAN
4464 Cass Ave.—C. D. Miller

KANSAS CITY 6, MISSOURI
903 McGee Street—T. Pollmeyer

LOS ANGELES 13, CALIF.
411 So. Wall St.—H. M. Hall

MINNEAPOLIS 15, MINNESOTA
712 Sixth Ave., So.—A. C. Jacobson

NEW YORK 18, N. Y.
55 West 42nd St.—H. C. Meyerga

ROCHESTER 4, N. Y.
825 Commerce Bldg.—S. E. Shea

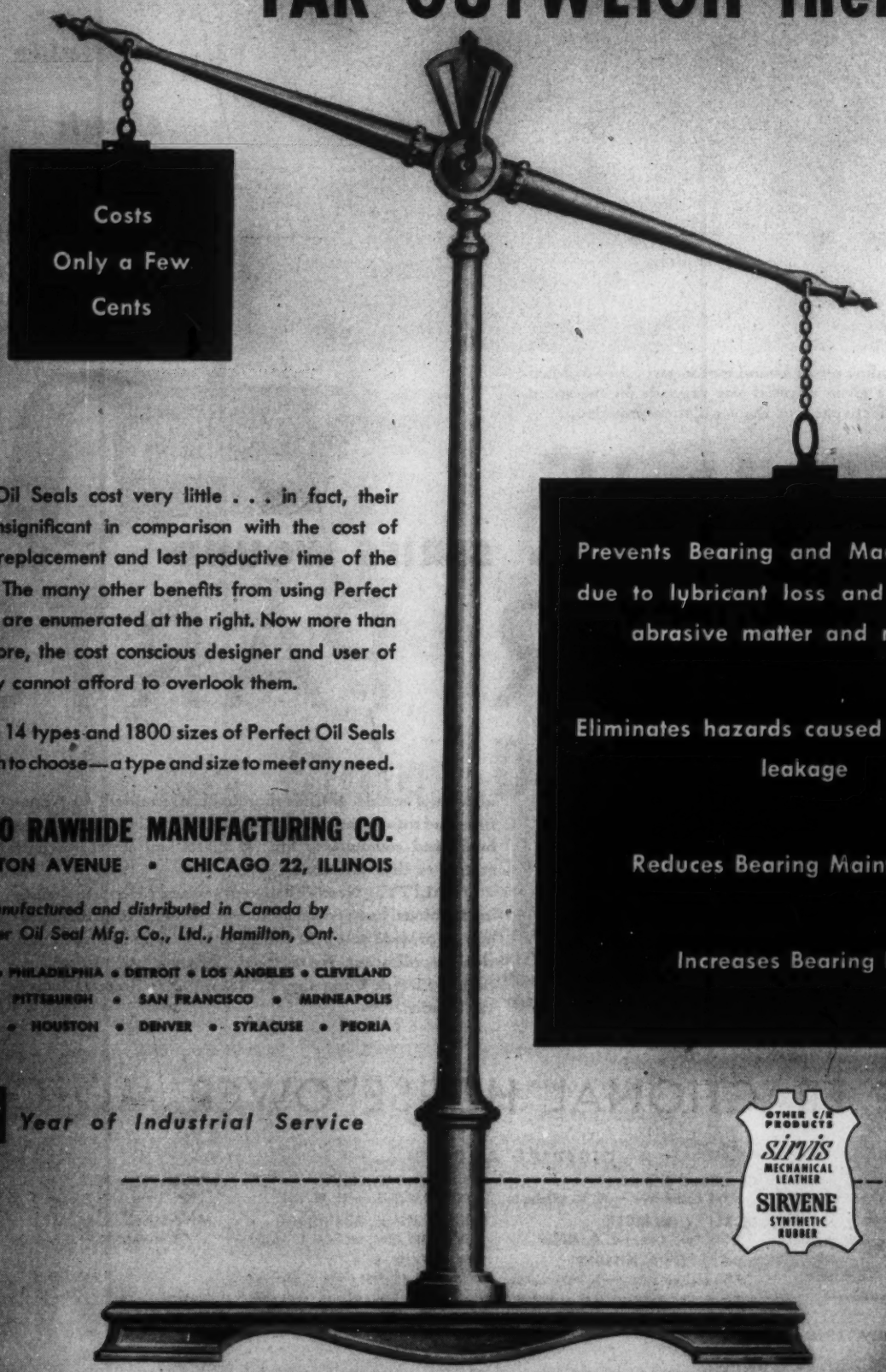
SAN FRANCISCO 3, CALIF.
995 Market St.—I. F. Cady

PERFECT

Oil Seals

PATENTED

. . . their benefits FAR OUTWEIGH their cost



Perfect Oil Seals cost very little . . . in fact, their cost is insignificant in comparison with the cost of bearing replacement and lost productive time of the machine. The many other benefits from using Perfect Oil Seals are enumerated at the right. Now more than ever before, the cost conscious designer and user of machinery cannot afford to overlook them.

There are 14 types and 1800 sizes of Perfect Oil Seals from which to choose—a type and size to meet any need.

Prevents Bearing and Machine failure due to lubricant loss and entrance of abrasive matter and moisture

Eliminates hazards caused by lubricant leakage

Reduces Bearing Maintenance

Increases Bearing Life

CHICAGO RAWHIDE MANUFACTURING CO.

1304 ELSTON AVENUE • CHICAGO 22, ILLINOIS

Manufactured and distributed in Canada by Super Oil Seal Mfg. Co., Ltd., Hamilton, Ont.

NEW YORK • PHILADELPHIA • DETROIT • LOS ANGELES • CLEVELAND
BOSTON • PITTSBURGH • SAN FRANCISCO • MINNEAPOLIS
CINCINNATI • HOUSTON • DENVER • SYRACUSE • PEORIA

Our 71ST *Year of Industrial Service*

OTHER C/R PRODUCTS
sirvis MECHANICAL LEATHER
SIRVENE SYNTHETIC RUBBER

MACHINE DESIGN

Vol. 21—No. 7 July, 1949

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

This Month's Cover: Pretzel tying machine has complex mechanism to duplicate manual motions of hand tying the pretzels. Design features of this novel machine are discussed in the article beginning on Page 74.

EDITORIAL STAFF

COLIN CARMICHAEL, *Editor*
JOHN W. GREVE, *Managing Editor*

Associate Editors

RICHARD K. LOTZ ROGER W. BOLZ

Assistant Editors

ROBERT R. HARNAR ROBERT E. DENEGA

FRANK H. BURGESS, *Art Editor*
B. R. HELM, *Art Assistant*

Consulting Editor

LAURENCE E. JERMY

New York.....B. K. PRICE, L. E. BROWNE
Chicago.....ERLE F. ROSS
Pittsburgh.....J. C. SULLIVAN
Detroit.....A. H. ALLEN
Washington.....E. C. KREUTZBERG
London.....VINCENT DELPORT

BUSINESS STAFF

G. O. HAYS, *Business Manager*
MARY L. CALLAHAN, *Advertising Service*

Chicago
H. H. DREYER J. M. WELLS
New York
R. H. SMITH E. S. LAWSON
Cleveland
H. B. VEITH
Los Angeles
F. J. FULLER

Circulation & Research

J. W. ZUBER, *Director*
JACK C. GERNHARD, *Readers Service*
R. L. HARTFORD, *Market Research*

Main Office

Penton Building, Cleveland 13, Ohio
Main 8260

Branch Offices

New York 17.....16 East 43rd St.
Murray Hill 2-2581
Chicago 11.....520 North Michigan Ave.
Whitehall 4-1234
Pittsburgh 19.....2806 Koppers Building
Atlantic 3211
Detroit 2.....6560 Cass Ave.
Madison 3024
Washington 4.....1123 National Press Bldg.
Executive 6849
Los Angeles 4..130 N. New Hampshire Ave.
Fairfax 1758
London, S.W.1....2 Caxton St., Westminster

Published by The Penton Publishing Co. E. L. SHANER, Chairman of the Board and Treasurer; G. O. HAYS, President; R. C. JAENKE, Vice President; F. G. STEINEBACH, Vice President and Secretary; E. L. WERNER, Assistant Treasurer.

Published on the seventh of each month. Subscription in the United States and possessions, Canada, Cuba, Mexico, Central and South America: One year $10. Single copies, $1.00. Other countries one year, $15. Copyright 1949 by The Penton Publishing Company. Acceptance under Act of June 5, 1934. Authorized July 20, 1934.

CCA NBP

CONTENTS

Reducing Assembly Costs (Editorial) 73

Pretzel Tying Machine—duplicates complex manual motions 74
By Russell G. Zuefle

Scanning the Field for Ideas 80
Magnetic fluid devices—ultra-high-speed electronic receiver—stainless steel blades—variable-pitch escapement

Speed-Control Methods—for electric motor drives 83
By Ferris L. Reed

A More Effective Drafting Room 100
By Clarence L. Pfeiffer

Tube Fittings—various designs and methods of sealing 106

First Gas Turbine Locomotive—completes preliminary road trials 110

Resonance Amplifies Forces in Vibration Machines 113
By J. Paul Walsh

Unified Tolerances Compared—for screw thread standards 116
By Glen H. Stimson

Torque Converter Transmission—utilizes automatic clutch 117
By J. G. Vincent and Forest McFarland

Film Pressures in Greased Sleeve Bearings 121
By Gunther Cohn and Jess W. Orcn

Panel Type Air Filters—selection and application 125
By Charles R. Sutherland

Hydraulic Fitting Standards for Industrial Equipment (Data Sheet) 133
By F. W. Robinson

DEPARTMENTS

Itemized Index 7
Topics 68
Designs of the Month 130
Noteworthy Patents 139
New Parts and Materials 140
Eng. Dept. Equipment 150
Helpful Literature 153
Assets to a Bookcase 156
Men of Machines 158
News of Manufacturers 162
Sales and Service Personnel 170
Sales Notes 174
Meetings and Expositions 178
Design Abstracts 180
New Machines 186

DESIGNING FOR PRODUCTION AND SALES · STYLING
MATERIALS SPECIFICATION · DESIGN ANALYSIS
MACHINE COMPONENTS · ENGINEERING MANAGEMENT

IT'S ALL FOR THE GOOD OF SIRVIS...

Steers are far from acrobatic. But, Sirvis steer-*hide* is bent in both directions like a hairpin to determine loose or cracky grain. While anyone can perform the simple bend test, its results are very important. For, in selecting hides for Sirvis mechanical leathers, only the smoother portions are used. Extreme wrinkling or "pipiness" in a given piece of leather usually indicates inferior strength and performance qualities. In many cases, it means poor fibre structure and thereby precludes the leather's use for mechanical purposes.

Pipiness must also be considered in the selection of leather for Sirvis mechanical boots, because extreme wrinkling naturally affects the smoothness and ease with which the leather will form. Leather which wrinkles or shows grain crackiness is similarly unsuitable for many other mechanical applications.

Chicago Rawhide engineers run the bend test with exceptional care. As a result, Sirvis mechanical leather is fine-grained, impervious to oil and water, and possesses extraordinary strength.

This is just one of the many laboratory-controlled tests to which Sirvis leathers are subjected . . . so that you may be assured of top quality in packings, seals, boots, gaskets, diaphragms, and other mechanical leather products. Because of extreme care in designing, excellence of materials and constant checks in production, Sirvis mechanical leathers are outstanding in dependability.

• *For detailed information about Sirvis products, write for the free Chicago Rawhide catalog*

OTHER C-R PRODUCTS
PERFECT OIL SEALS
SIRVENE SYNTHETIC RUBBER

MECHANICAL LEATHER PRODUCTS

sirvis

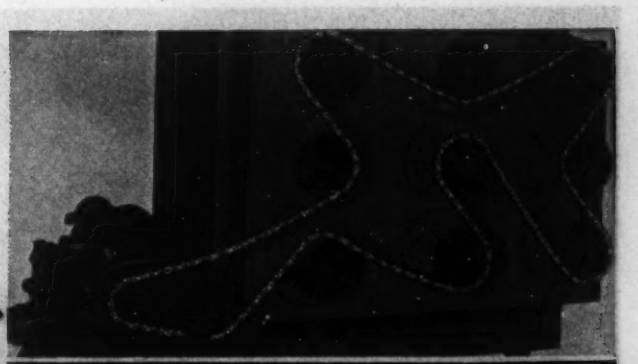
CHICAGO RAWHIDE MANUFACTURING COMPANY

1304 Elston Ave., Chicago 22, Illinois

New York • Philadelphia • Detroit • San Francisco • Cleveland • Boston
Pittsburgh • Los Angeles • Cincinnati • Minneapolis • Syracuse • Peoria

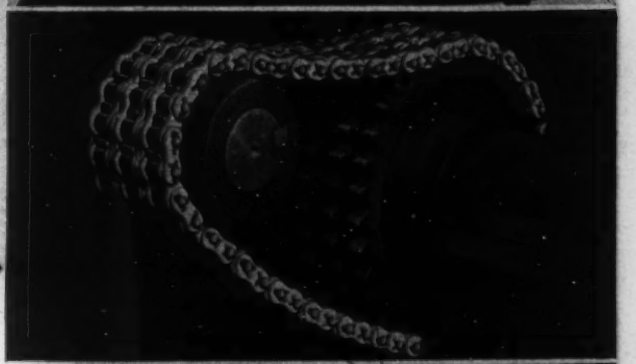
FLEXIBLE!

Link-Belt Silverlink Precision Steel Roller Chain is flexible; a series of linked rollers that form a flowing highway of power.



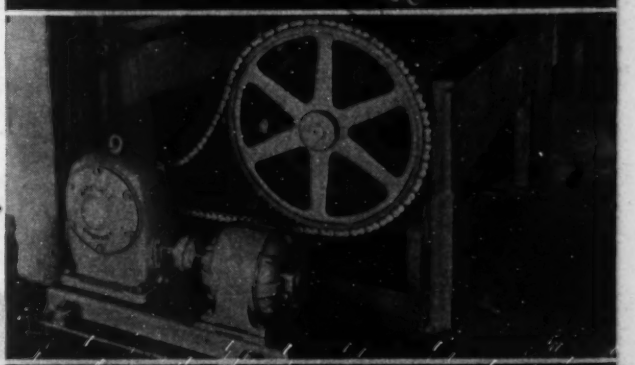
POWERFUL!

Link-Belt Silverlink Precision Steel Roller Chain can be applied to small fractional horsepower machines or to units involving more than a thousand horsepower.



SHORT CENTERS!

Link-Belt Silverlink Precision Steel Roller Chain can be used on short centers at high ratios. Adapted to withstand heavy starting loads and severe shock.



LONG CENTERS!

Link-Belt Silverlink Precision Steel Roller Chain is adapted to coordinate motion of widely separated shafts, affording positive operations.

RELIABLE!

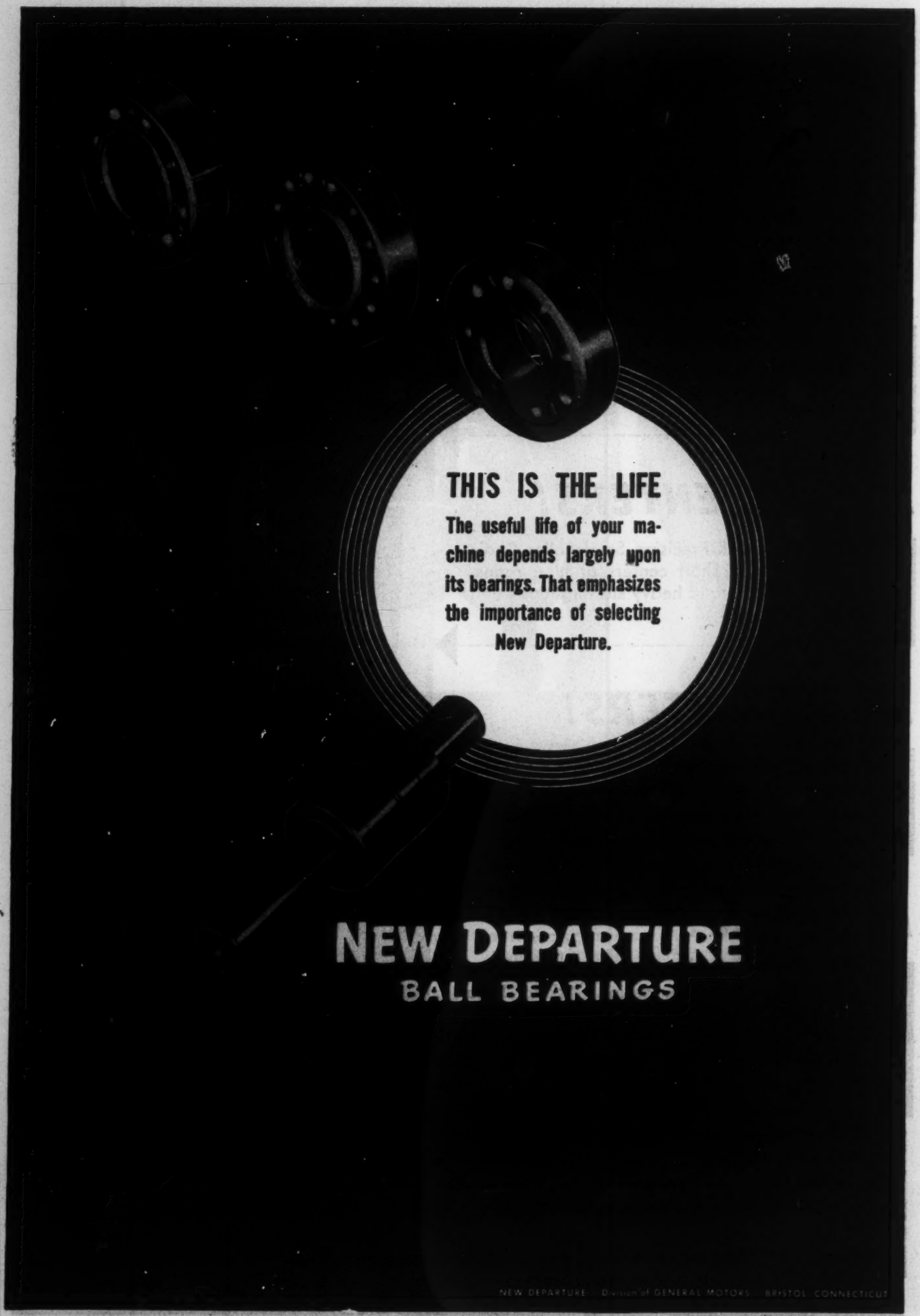
Made by Link-Belt—your guarantee of superior construction and proper design. Ask for Data Book No. 1957-A.

LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Houston 3, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in Principal Cities. 11,473

LINK-BELT

ROLLER CHAINS & SPROCKETS

World's largest makers of Chains for Power Transmission and Conveying


THIS IS THE LIFE
The useful life of your machine depends largely upon its bearings. That emphasizes the importance of selecting New Departure.
NEW DEPARTURE
BALL BEARINGS
NEW DEPARTURE Division of GENERAL MOTORS BRISTOL, CONNECTICUT

Wichita City Librar

Itemized Index

Classified for convenience when studying specific design problems

Design and Calculations

Blades build up construction, Edit. 82
Drafting room, Edit. 100-105
Gas turbine locomotive, Edit. 110-112
Mechanism duplicates tying motions, Edit. 74-79
Panel type air filters, selection of, Edit. 125-129
Rack variable escapement, Edit. 82
Resonance used in vibration testing machines, Edit. 113-115
Sleeve bearings, lubrication of, Edit. 121-124, 172
Speed control of motors, Edit. 83-99
Torque converter transmission, for Packards, Edit 117-120, 168
Tube fittings, Edit. 106-109
Unified screw thread tolerances, Edit. 116

Engineering Department

Equipment, Edit. 100-105; Adv. 29, 157, 185
Instruments, Edit. 100-105; Adv. 29, 163
Management, Edit. 100-105
Supplies, Adv. 29, 32, 226
Testing equipment, Adv. 185

Finishes

For aluminum, Adv. 28

Materials

Aluminum alloys, Adv. 47
Beryllium, Adv. 180
Brass, Adv. 53, 54, 204
Bronze, Adv. 11, 53, 54
Copper alloys, Adv. 53, 54, 204
Felt, Adv. 177
Friction materials, Adv. 197
Graphite, Adv. 44, 45, 181
Gray Iron, Adv. 233
Meehanite, Adv. 66
Nickel alloys, Adv. 213
Plastics, Adv. 35, 36, 48, 67, 225, 245
Rubber and synthetics, Adv. 40, 67
Steel, Adv. 70, 71, 203
Steel, stainless, Adv. 203, 221, 227, 247

Parts

Air conditioning, Adv. 236
Balls, Adv. 222
Bearings:
- Ball, Adv. 6, 178, 186, 193, 205, 219, 229, 232
- Needle, Adv. 202
- Roller, Adv. 51, 202, 217, 229, 249
- Sheet, Adv. 145
- Sleeve, Edit. 121-124, 172; Adv. 11, 27, 52, 145, 181

Bellows, Adv. 235
Belts, Adv. inside front cover, 40, 160, 226, 231, 239
Blowers, Adv. 236
Brakes, Adv. 70, 137
Brushes, carbon, Adv. 46
Bushings, Adv. 11, 167, 236
Cams, Edit. 78; Adv. 228
Carbon parts, Adv. 46
Carburetors, Adv. 210
Castings:
- Die, Adv. 72
- Permanent mold, Adv. 70
- Sand, Adv. 27, 66

Chains:
- Conveyor, Adv. 14, 15
- Roller, Adv. 5, 64, 69, 209
- Sprockets, Adv. 5, 64

Clutches, Edit. 75; Adv. 149, 165, 187, 219, 222, 224, 240
Collars, Adv. 230
Compressors, Adv. 236
Controls (see Electric, etc.)
Counters, Adv. 16
Couplings, Adv. 70, 219
Cylinders, Adv. 163, 168, 174, 182, 218, 240
Electric controls:
- Circuit breakers, Adv. 175
- Contactors, Adv. 242
- Control assemblies, Edit. 83-99; Adv. 56, 223, back cover
- Magnetos, Adv. 43
- Rectifiers, Adv. 212
- Resistors, Adv. 170, 171, 172
- Solenoids, Adv. 30, 31
- Switches, Adv. 60
- Terminal boards, Adv. 232
- Thermostats, Adv. 24
- Timers, Adv. 58, 162
- Transformers, Adv. 30, 31
- Voltage regulators, Adv. 57

Electric generators, Adv. 25, 223
Electric motors, Edit. 83-99; Adv. inside front cover, 1, 12, 20, 25, 30, 37, 56, 58, 62, 162, 169, 191, 195, 211, 223, 226, 230, 237, 243
Electric motor parts, Adv. 62
Engines, Adv. 176, 220, 239, 244
Fasteners:
- Locking, Adv. 13, 70, 194, 228
- Nuts, bolts, screws, Adv. 159, 173, 190, 214, 216, 230, 250

Filters, Adv. 41
Fittings, Edit. 106-109; Adv. 26, 34
Forgings, Adv. 47, 49, 63, 221
Gears, Edit. 75; Adv. 19, 33, 39, 194, 196, 221, 224, 232, 236, 244
Generators, (see Electric generators)
Graphite parts, Adv. 44, 45, 181
Hose (see Tubing)
Hydraulic and pneumatic equipment:
- Cylinders, Adv. 22, 23, 218
- Pumps, Adv. inside front cover, 22, 23, 65, 70, 182, 207, 218, 224, 228, 236, 242
- Systems, Adv. 9
- Valves, Adv. 22, 70, 218, 220, 239

Joints, Adv. 237
Leather parts, Adv. 4
Lubrication and equipment, Edit. 121-124, 172; Adv. 55, 166, 184, 229
Motors (see Electric motors)
Pins, dowel, Adv. 190
Pipe, Adv. 26
Plastic parts, Adv. 35, 36, 67, 161, 164, 183
Plugs, Adv. 240
Pneumatic equipment (see Hydraulic and pneumatic)
Pulleys and sheaves, Adv. 57, 226
Pumps (see also Hydraulic and pneumatic), Adv. inside front cover, 65, 70, 182, 207, 218, 228, 236, 242
Rings, retaining, Adv. 59
Rubber and synthetic parts, Adv. 8, 67, 192, 242
Screw machine parts, Adv. 215, 237
Seals, packings, gaskets, Adv. 2, 10, 67, 147, 155, 201, 208, 220, 237, 239
Sheaves, Adv. 219
Speed changers, Adv. 39, 57, 188, 236, 245, inside back cover
Springs, Adv. 70, 237, 245
Stampings, Adv. 70
Transmissions, variable speed, Edit. 75
Tubing:
- Flexible, Adv. 34, 184, 189, 222, 235
- Metallic, Adv. 34, 50, 179, 184, 198, 206, 222, 235
- Nonmetallic, Adv. 151
- Structural, Adv. 179, 198, 206

Universal joints, Adv. 230
Valves (see also Hydraulic and pneumatic), Adv. 26, 42, 70, 163, 174, 182, 218, 220, 224, 239
Washers, Adv. 243
Weldments and equipment, Adv. 38

Production

Facilities, general, Adv. 72, 159, 167, 179, 225, 228, 243, 244
Forging, Adv. 63
Hardening, Adv. 199
Machines, special, Edit. 130; Adv. 21, 33
Measuring, Edit 131
Screw machine, Adv. 215, 237
Testing and equipment, Edit. 132; Adv. 33, 61, 200

MACHINE DESIGN is indexed in Industrial Arts Index and Engineering Index Service, both available in libraries generally.

Fiftieth Anniversary Year

Acadia

SYNTHETIC RUBBER

There is no great chemical secret nowadays about synthetic rubber. Its ingredients are generally known throughout industry. But there *is* a great difference in the methods, equipment, personnel and inspection in its manufacture. Acadia Synthetic rubber, wherever employed, is widely recognized as "tops."

Your Insurance Against Complaints

Practically all products in the durable goods fields are made up of many parts. Some have a very modest function and rarely are considered by the buyer. But when one of these components (synthetic rubber for example) is poorly made and service is required, the high reputation of your product suffers. So insist on the best—insist on Acadia Synthetic Rubber. Here are a few reasons: It is processed by the very latest mechanical equipment—is held to closest possible tolerances for non-metal cut and molded parts—unusual attention given to maintain uniformity of quality—maximum elasticity, resilience, plasticity—greater resistance to oil, heat, light, wear, age, etc.

Acadia Synthetic Rubber is available in sheets, tubing, strips, channel, extrusions, molded and cut parts, washers, seals, etc. Specify the particular characteristics desired. Acadia engineers are prompt in helping you determine the compound and qualities to best meet your requirements.

DIVISION OF WESTERN FELT WORKS

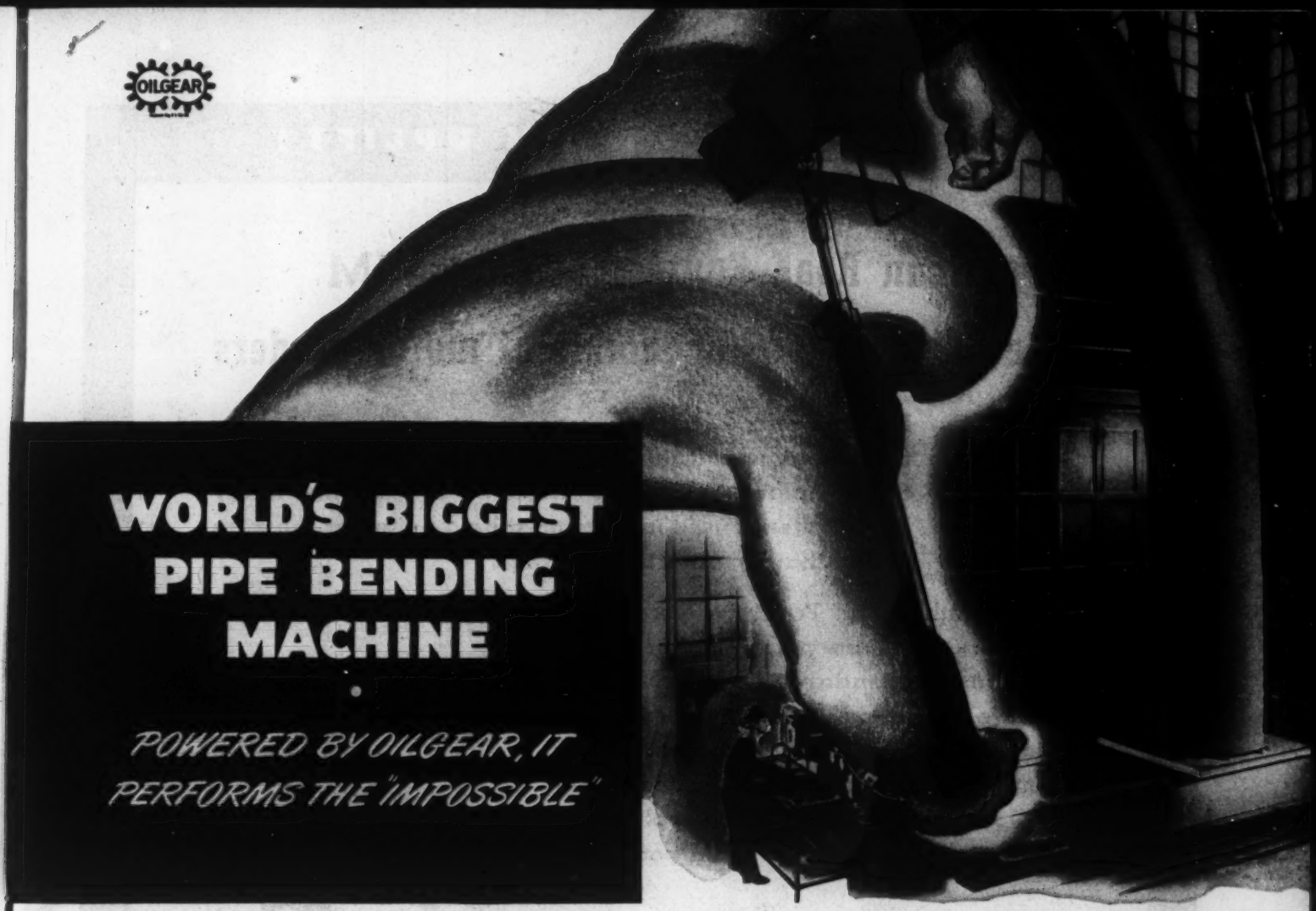
ACADIA Synthetic PRODUCTS

Processors of Synthetic Rubber and Plastics • Sheets Extrusions • Molded Parts

DIVISION WESTERN FELT WORKS

4035-4117 Ogden Avenue, Chicago 23, Illinois

100 A



WORLD'S BIGGEST PIPE BENDING MACHINE

POWERED BY OILGEAR, IT PERFORMS THE "IMPOSSIBLE"

Oilgear DP-1225 Pump and two 7½ x 156" stroke Cylinders used on "world's largest" pipe bending machine designed and built by The M. W. Kellogg Co. engineers. Pump stroke, hence speed of bending operation, regulated to an infinite degree.

Prior to the advent of the machine pictured above it was just not possible to bend a pipe over 30 inches in diameter without its buckling and distortion beyond the point of usefulness.

Yet the big "cat" crackers that have come up during and since the war made imperative the use of pipe three, four and five feet in diameter . . . and of course *bends* in such pipe. Bends bigger than the 30-inch diameter had to be fabricated of angular welded sections.

So slow and costly was this process, so troublesome the results in the field that The M. W. Kellogg Company engineers set themselves the task of solving the problem of bending big diameter pipe; and they called in Oilgear to help. The result of long endeavor was the world's biggest pipe bending machine turning out the world's biggest "bends". This machine is so successful that it has produced perfectly contoured bends for the largest catalyst carrier lines ever fabricated.. Since its first day, it has saved time, money, labor . . . in the set-up, in the bending operations, in the greatly improved performance of such pipe in the field.

Here is just one of hundreds of machine and process problems "impossible" of solution to begin with, but solved either directly or indirectly through the application of Oilgear engineering and Oilgear equipment. Why don't you find out what Oilgear can do for you? Many different functions are available. Savings in time and money and labor plus improvements in quality are the result. The Oilgear Company, 1568 West Pierce Street, Milwaukee 4, Wisconsin.

Oilgear

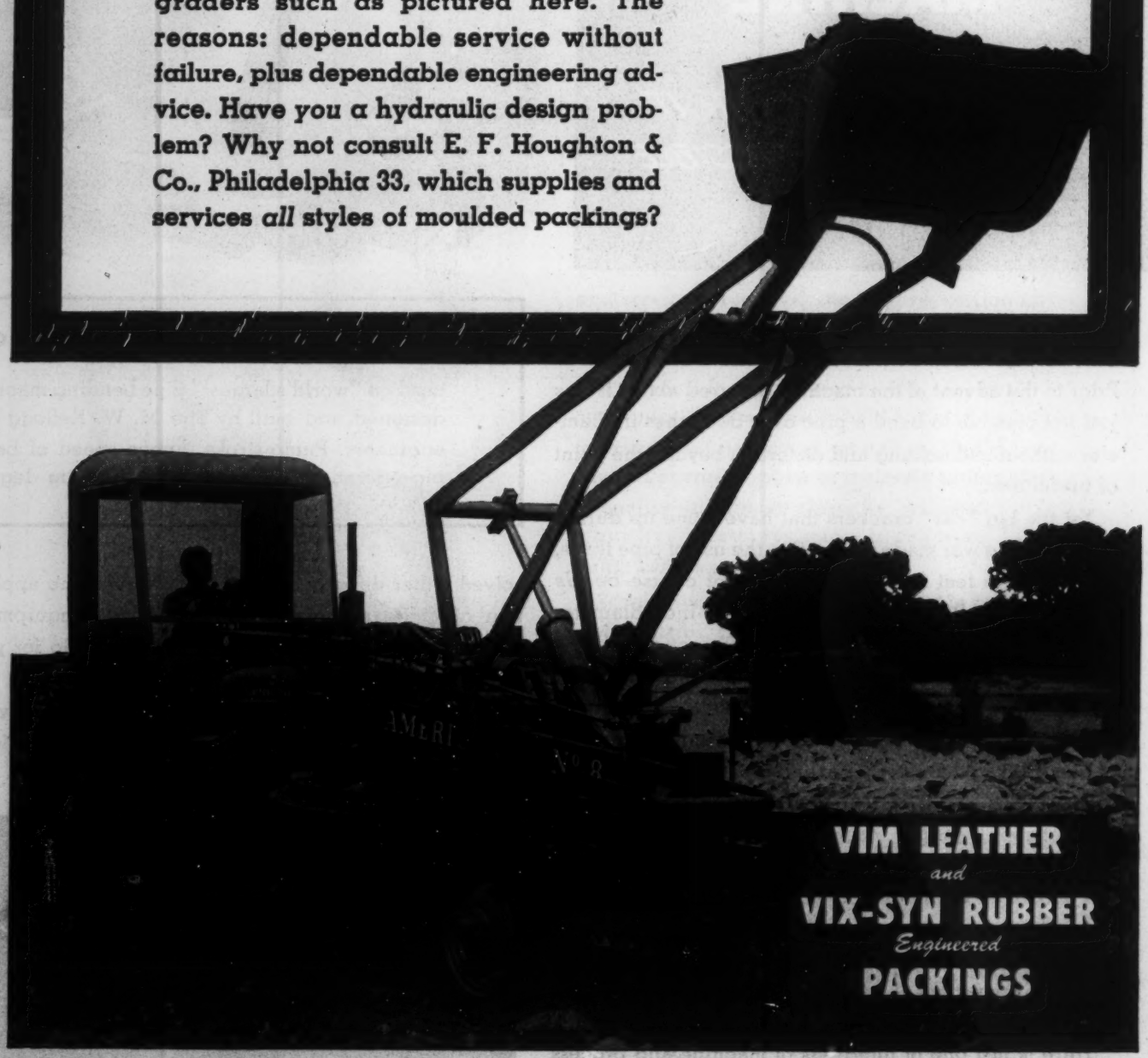
LOW-DOWN ON AN UPLIFT!

American Road Equipment uses VIM leather packings on hoists of motor graders

VIM *Leather Cup Packing used in hoist*

Bulldozers and graders absorb plenty of punishment in their rough jobs. Their hydraulic equipment that enables them to move earth so fast must be dependable. Every basic material used in them must hold up under pressure —and that includes the packings.

VIM Leather Cup Packings were chosen for pistons on American graders such as pictured here. The reasons: dependable service without failure, plus dependable engineering advice. Have you a hydraulic design problem? Why not consult E. F. Houghton & Co., Philadelphia 33, which supplies and services *all* styles of moulded packings?



VIM LEATHER
and
VIX-SYN RUBBER
Engineered
PACKINGS

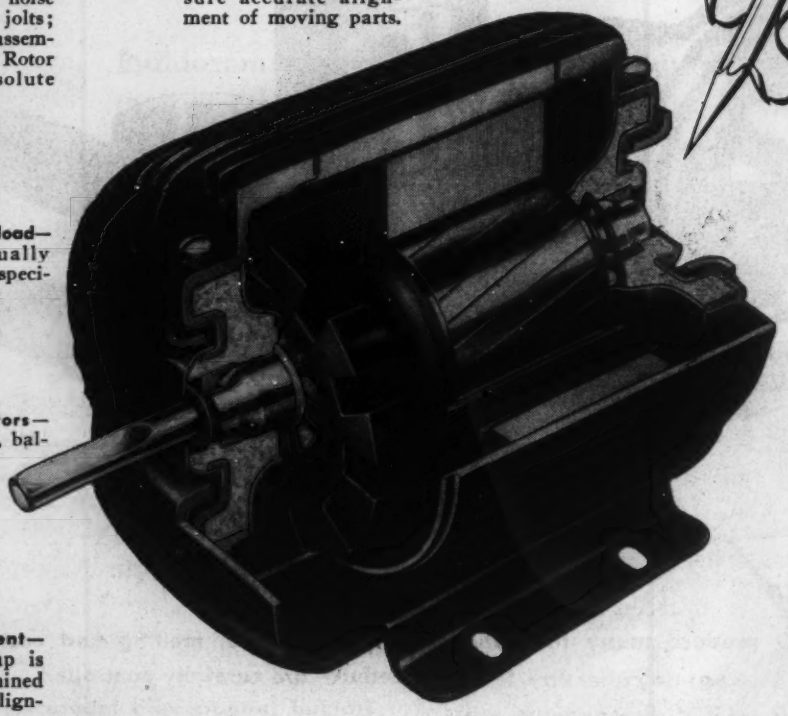
To produce many thousands of cast bronze bearings day after day to the uniformly high quality synonymous with the name Bunting requires precise foundry control. This control starts with the raw materials necessary for production such as molding and core materials, core binders, fixed carbon fuel, pre-alloyed metal in ingot form purchased to Bunting's own rigid specifications, and virgin metals used for ladle additions to control metal composition. Then, too, melting and casting procedures are carefully controlled.
Trained foundry and laboratory personnel as well as chemical and metallurgical equipment of the latest design are required to carry on this exact control. Bunting has always taken pride in being the leading producer of bearing bronze of the highest quality and has the facilities to maintain this leadership. The Bunting Brass & Bronze Company, Toledo 9, Ohio. Branches in principal cities.
Bunting®
BRONZE BEARINGS
BUSHINGS
PRECISION BRONZE BARS

Take time to look...

...INSIDE

Controlled end play—Takes shock and noise out of end play jolts; allows precision assembly into your unit. Rotor remains at absolute magnetic center.

Rugged housings—Assure accurate alignment of moving parts.



H.P. rated at full load—Motors individually tested to assure specified h.p. rating.

Super-safe lubrication—Extra large reservoirs with recirculation of lubricant.

Flush surface rotors—For quiet, smooth, balanced operation.

Individually fitted bearings—Fitted to the shaft at .0001" tolerance, at clearance of .0005".

Accurate alignment—Concentric air gap is assured by machined frame and self-aligning bearings.

Precision field construction—Machine wound, varnish baked coils are highly resistant to oil and humidity.

Redmond MICROMOTORS

There's a lot of difference in today's electric motors.

Outwardly, they all conform pretty much to a general pattern for each particular type, size and purpose.

But the experienced buyer of motors knows that the *real character*—the *genuine worth*—of a motor lies beneath the outer shell.

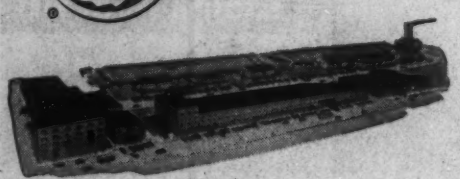
That's why Redmond advises, "Take Time to Look Inside."

For Redmond Micromotors look better, the more they are examined, the more they are compared. Look inside a Redmond Micromotor and you will find a list of features unmatched by any other make.

Look inside and you will learn why Redmond Micromotors give you the smoothest, quietest, longest-lasting service you've ever known in an electric motor.

Yes, take time to Look Inside. You'll *see* the difference!

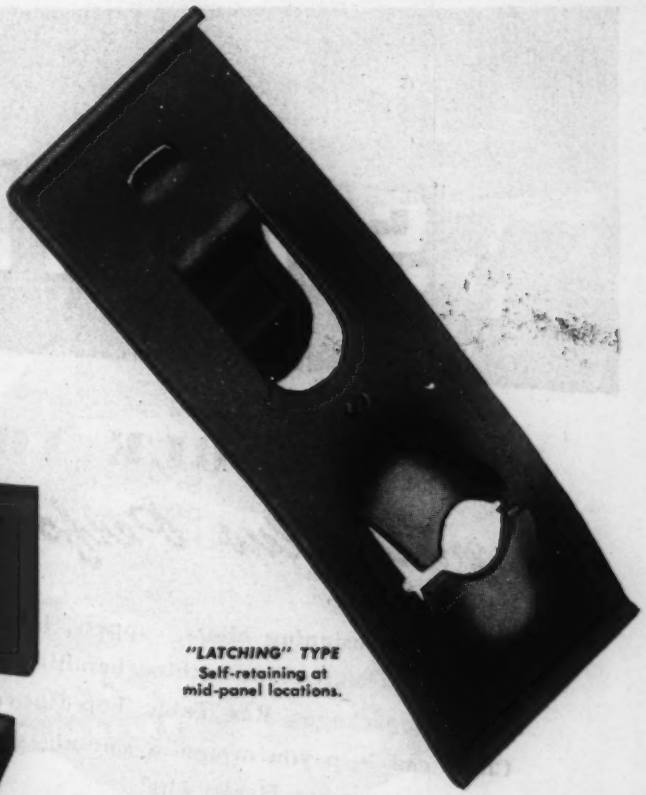
150 standard models, 25 types, up to 1/10th h.p. A.C. and D.C. Illustrated is the type "Y" A.C. Micromotor.



Redmond COMPANY, INC., OWOSSO, MICHIGAN

Offices in: New York, Chicago, Los Angeles, Dallas

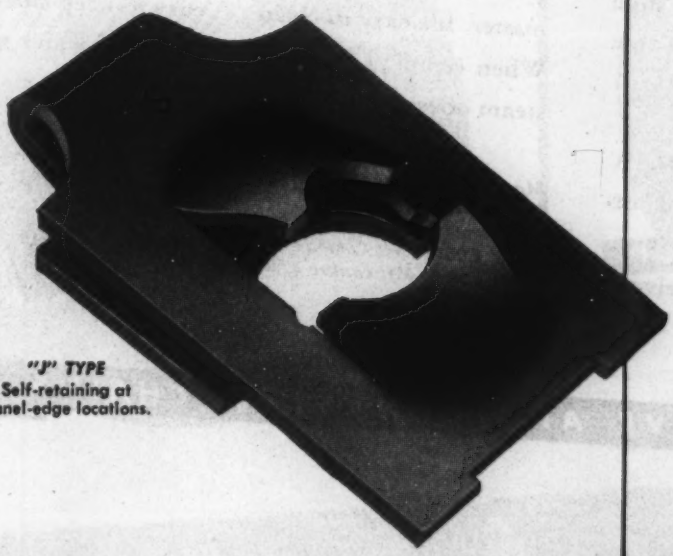
FASTER ... EASIER *and* TIGHTER!



"LATCHING" TYPE
Self-retaining at mid-panel locations.

SEND FOR THIS FREE SAMPLE KIT!

Check the operating and performance advantages of Shakeproof SPEED NUTS right in your own assembly procedure



"J" TYPE
Self-retaining at panel-edge locations.

Shakeproof "SPEED NUTS" outperform ordinary nuts in all three basic elements of fastener performance... speed of assembly, ease of tightening and resistance to vibration loosening. They tighten quickly and provide a positive, vibration resistant thread lock without extreme torque.

And, when the "SPEED NUT" principle is incorporated in specially designed fastening devices, performance advantages—and savings—multiply! The two Shakeproof "SPEED NUT" Types illustrated here, specially designed to simplify assembly at hard-to-reach fastening points, typify the advantages of "engineered" application of the "SPEED NUT" principle. Test Shakeproof "SPEED NUTS" in your particular application . . . see how you can save! Send for your *free* testing sample kit today!

SHAKEPROOF, inc., Division of Illinois Tool Works, 2501 North Keeler Avenue, Chicago 39, Illinois.

FASTENING HEADQUARTERS
TRADE MARK

Shakeproof SPEED NUTS*

*T. M. Reg. U. S. Pat. Off. by Tinnerman Products, Inc.

REX TABLE TOP CHAIN

puts Plus Performance in your designs

If you're designing fillers, cappers, labelers, washers, pasteurizers or machines handling small parts or packages, Rex Table Top Conveyor Chain can help you design-in smooth, steady product movement. Here's why!

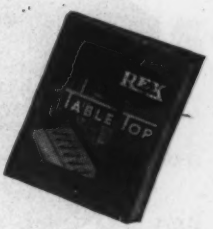
TABLE TOP ELIMINATES PILE-UPS AND SPILLAGE. The exclusive, hinged joint construction assures a constant carrying surface. There is no continuous gap across the width of the links as the chain flexes over sprockets to catch and trip containers. Accurately beveled edges allow smooth transfers . . . permit the chain to slide freely from under blocked containers. And Table Top will not tear paper cartons.

TABLE TOP HAS A SIMPLIFIED DESIGN. A one-piece platform link of case-hardened or stainless steel and a husky rivet is all there is to Table Top. There are no attachments or rivets to "loosen" or "wobble." Fewer parts mean greater steadiness, less chance for breakage, greater all-round efficiency.

TABLE TOP LASTS LONGER. The entire Table Top link absorbs the pulling load. Sprocket tooth bearing pressure is spread over the entire length of the joint not concentrated on a small area. This feature alone accounts for a great part of Table Top's longer service life.

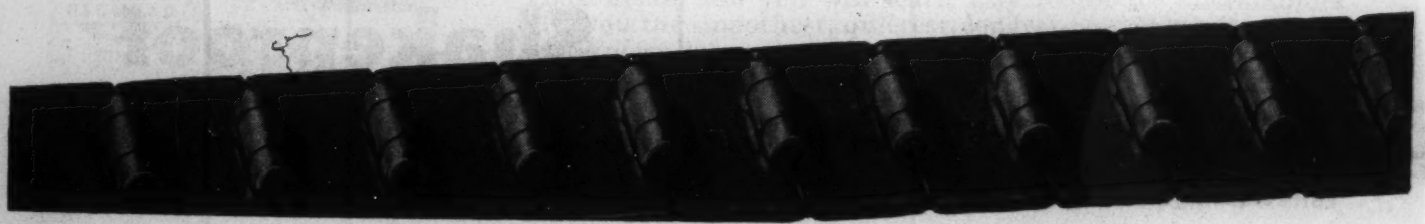
TABLE TOP STAYS CLEANER. There are no pockets on Table Top to catch and hold foreign matter. It's easy to clean . . . easy to keep clean. When cleaning is necessary, a jet of water or steam does the job in a hurry.

Many sizes of Table Top are available for immediate delivery. For all the facts, send for your copy of Bulletin No. 47-15. Chain Belt Company, 1643 West Bruce Street, Milwaukee 4, Wisconsin.



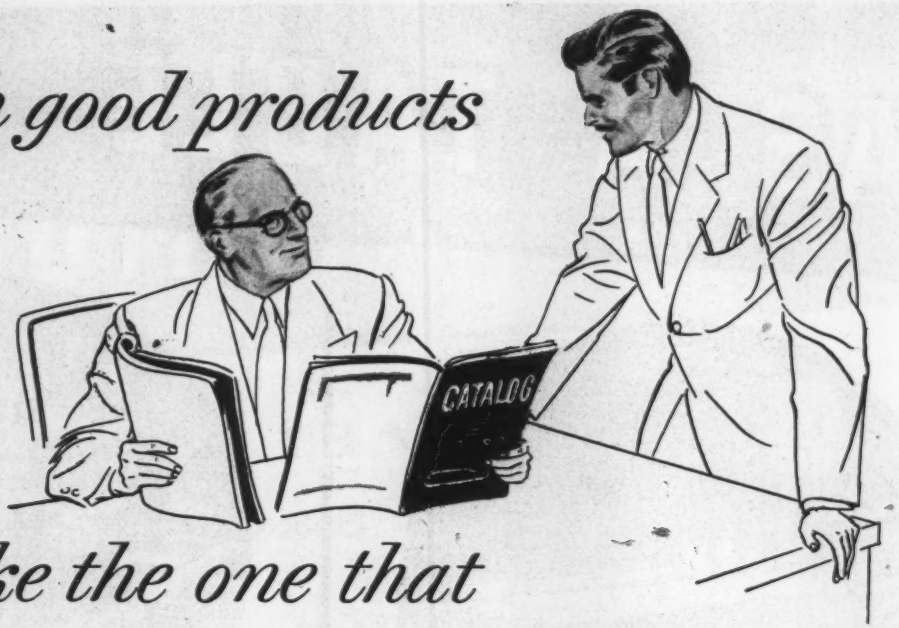
CHAIN BELT REX COMPANY

DRIVE AND CONVEYOR CHAINS



AS A TABLE TOP..

"They're both good products



...but I'll take the one that can COUNT!"

ALL other points being equal, sales are often settled by one product's *extra* usefulness... such as the *ability to count*.

That's why a Veeder-Root Counter, *built into your product as an integral part*, is plainly good business . . . a hefty punch in today's slugfest for sales.

There are all kinds of Veeder-Root Counters, mechanical and electrical, to count in all units and terms . . . to enable your product to keep its own production records, prove its own service guarantee, and to give your customers protection in many ways against errors, delays, and waste. If there is *any* sales-building way in which your product can be equipped to count . . . then you can *count on Veeder-Root* to show you how. Write!

8-PAGE CONDENSED CATALOG shows Veeder-Root Counters for mechanical, electrical and manual operation. Write for a free copy

Veeder-Root COUNTERS

VEEDER-ROOT INC., HARTFORD 2, CONNECTICUT

In Canada: Veeder-Root of Canada, Ltd., 955 St. James Street, Montreal 3. *In Great Britain:* Veeder-Root Ltd., Kilspindie Road, Dundee, Scotland.

Further Information?

IF YOU DESIRE MORE INFORMATION ON ANY ADVERTISEMENT IN THIS ISSUE

Here's What You Do:

Write the name of the advertiser and the page number of the ad in the spaces provided on the card. Check the type of information you want—whether it has to do with price, where you can buy it, or more needed details—or all three, if you wish. After you have finished going through MACHINE DESIGN and have jotted down all the ads on which you'd like more information, just tear off the card and drop it in the mail. No postage is required. We'll have our staff forward this information immediately to the advertiser, so that you will be relieved of the necessity of writing a number of letters. You will then hear directly from the advertiser, answering your request. Because we know that MACHINE DESIGN gets around, and that more than one person sees your copy, we have made up three cards so that if you are one of the later readers, you can still have the opportunity of taking advantage of this service.

Please send further information on the following advertisements in this issue:

PAGE NO.	NAME OF ADVERTISER	Send Technical Data	Send Price Information	Nearest Source of Supply
		○	○	○
		○	○	○
		○	○	○
		○	○	○
		○	○	○

YOUR NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

MD7-49

FIRST CLASS
PERMIT No. 36
(Sec. 510 P.L.&R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed In the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Cleveland 13, Ohio

Reader's Service Dept.

Please send further information on the following advertisements in this issue:

PAGE NO.	NAME OF ADVERTISER	Send Technical Data	Send Price Information	Nearest Source of Supply
		○	○	○
		○	○	○
		○	○	○
		○	○	○
		○	○	○

YOUR NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

MD7-49

Further Information?

FIRST CLASS
PERMIT No. 36
(Sec. 510 P.L.&R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Cleveland 13, Ohio

Reader's Service Dept.

Please send further information on the following advertisements in this issue:

PAGE NO.	NAME OF ADVERTISER	Send Technical Data	Send Price Information	Nearest Source of Supply
		○	○	○
		○	○	○
		○	○	○
		○	○	○
		○	○	○

YOUR NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

MD7-49

FIRST CLASS
PERMIT No. 36
(Sec. 510 P.L.&R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Cleveland 13, Ohio

Reader's Service Dept.

IF YOU DESIRE MORE INFORMATION ON ANY ADVERTISEMENT IN THIS ISSUE

Here's What You Do:

Write the name of the advertiser and the page number of the ad in the spaces provided on the card. Check the type of information you want—whether it has to do with price, where you can buy it, or more needed details—or all three, if you wish. After you have finished going through MACHINE DESIGN and have jotted down all the ads on which you'd like more information, just tear off the card and drop it in the mail. No postage is required. We'll have our staff forward this information immediately to the advertiser, so that you will be relieved of the necessity of writing a number of letters. You will then hear directly from the advertiser, answering your request. Because we know that MACHINE DESIGN gets around, and that more than one person sees your copy, we have made up three cards so that if you are one of the later readers, you can still have the opportunity of taking advantage of this service.

G.S. Small Gearing Transmits the Power in Chicago Electric's *"Handyhot"* Washer

THE soft, smooth purr of G.S. precision gearing is characteristic of the "HANDYHOT" Washer and other fine appliances by Chicago Electric. Extremely particular about the components they buy, this quality manufacturer knows they can depend upon G.S. for uniform accuracy together with the economy that only *highly efficient* mass production can give. Long experience in the quantity production of Fractional Horsepower Gearing exclusively has given G.S. craftsmen the knowledge and facilities required to make BETTER gears at reasonable cost. Learn why G.S. has become the "World's Largest Exclusive Manufacturer of Fractional Horsepower Gears". Let a G.S. engineer give you ideas, suggestions and cost estimates. There's no obligation. Write or phone today!

SEND FOR *our 4 page catalog bulletin illustrating and describing many different types and applications of G.S. Small Gearing. It may offer valuable suggestions and ideas you can use. Write today.*

FRACTIONAL HORSEPOWER GEARS

GS

GEAR Specialties

Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding

2635 WEST MEDILL AVENUE · CHICAGO 47, ILLINOIS

MEMBER OF AGMA

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

Centrifugal forces over

250,000 times gravity

The terrific centrifugal forces, precision control, and utmost dependability required in operation of this fine laboratory device dictated special motor requirements. *EEMCO* engineers developed this special motor application to provide a powerful precision-speed-controlled electric drive capable of hundreds of hours of high speed operation without attention. The 1-1/2 hp motor operates on 110-volt current, AC or DC, at 12,000 rpm. It is both air and water cooled.

The manufacturers of the *"Spinco"* Ultracentrifuge, *Specialized Instruments Corporation,* Belmont, Calif., called on *EEMCO* for services typical of special motor development and manufacture performed by *EEMCO* for leading companies in diverse lines throughout the nation. *EEMCO* has solved the widely varying electric drive problems of manufacturers of ultrasonic sound generators, oil well recovery tools, power saws, radar equipment, submersible pumping units, aircraft, and dairy homogenizers.

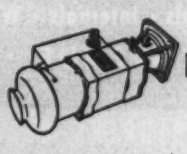
EEMCO-designed motors and drive units have solved the very toughest problems of function, power, size, weight, shape, performance, installation and operation. Perhaps you need a completely special design...or we may be able to adapt a basic *EEMCO* design to meet your needs. Let *EEMCO* tackle *your* motor problem.

ELECTRICAL ENGINEERING and MFG. CORP.

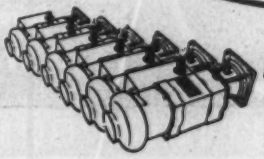
4606 West Jefferson Blvd., Los Angeles 16, California

EEMCO

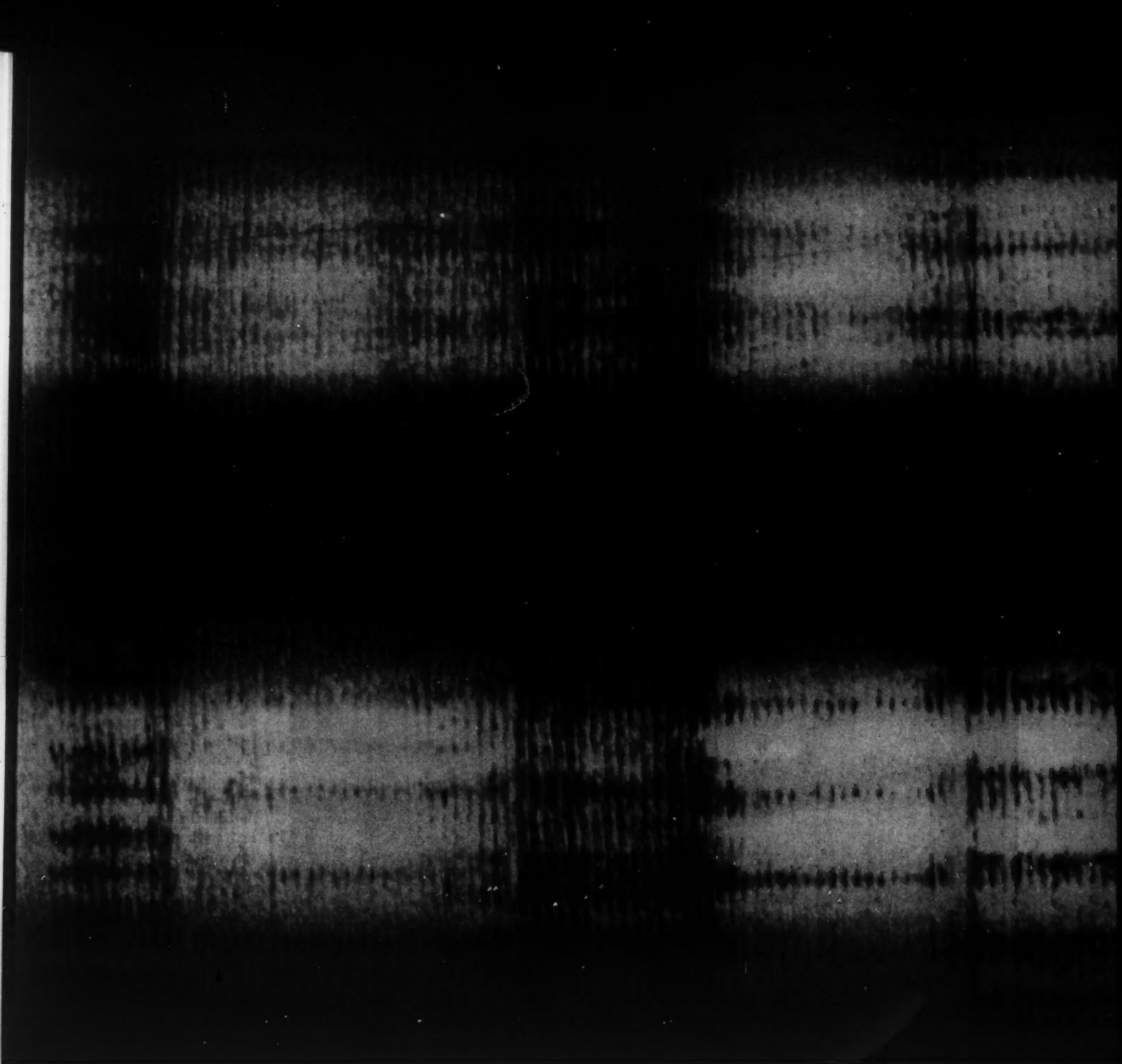
SPECIAL MOTOR DESIGN



DEVELOPMENT



MANUFACTURING



Do your bearings just *"hit the High Spots"?*

● You can't avoid this sort of thing without Superfinishing. This steel shaft, finely ground to 14 micro inches, shows typical "high spots" after the break-in period. These black areas, amounting to about 35% of the total bearing surface, carry the entire load. Thus, it's not a full bearing.

Had this part been Superfinished, the cylindrical form would be geometrically improved. The area contact of the Superfinishing stone would remove the sharp peaks, ridges, feed and chatter marks, "smear metal" and other irregularities. The result would be a more uniform bearing surface which would last infinitely longer.

This is but one of many interesting phases of Superfinishing explained in the new textbook, "Wear and Surface Finish." Please use your company letterhead when requesting it.

GISHOLT
MACHINE COMPANY
Madison 10, Wisconsin

THE GISHOLT ROUND TABLE

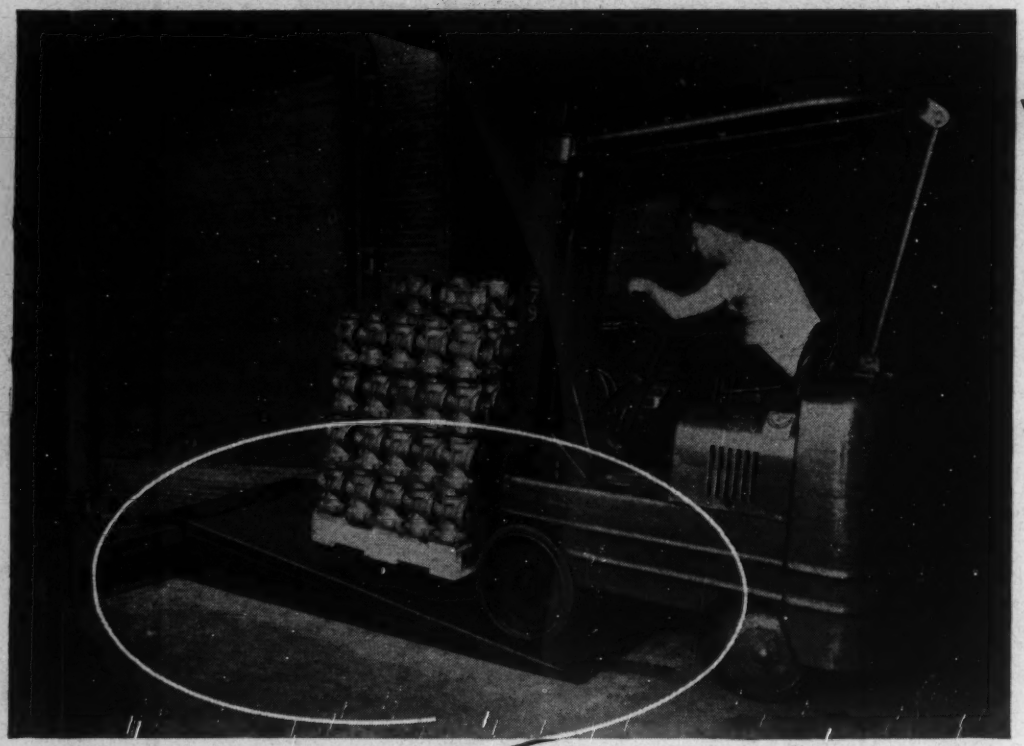
represents the collective experience of specialists in the machining, surface-finishing and balancing of round and partly round parts. Your problems are welcomed here.

TURRET LATHES • AUTOMATIC LATHES • SUPERFINISHERS • BALANCERS • SPECIAL MACHINES

LOOK HOW BLACKHAWK*

*High-Pressure Hydraulics**

SOLVED THIS MANUFACTURER'S PROBLEMS



"RAMPING" is made CHEAPER, EASIER, SAFER

These two pages tell the interesting story behind the popular "Two-way Loading Ramp." Its manufacturer uses Blackhawk hydraulic components. Left — a Pittsburgh installation, in daily service, carrying up to 5 tons and many off-center loads.

THE ENGINEERING AND SALES PROBLEMS:

The manufacturer of this unique "Two-Way Loading Ramp" needed a power-driven hydraulic system to raise or lower the ramp for precise contact with the truck or car floor. The hydraulic system had to match these requirements: (1) LOW COST — to permit reaching the largest possible market; (2) A SAFETY FACTOR — to handle heavy and off-center loads; (3) EXTRA SALES APPEAL through elimination of special on-the-job engineering.

THE ANSWERS SUPPLIED BY BLACKHAWK

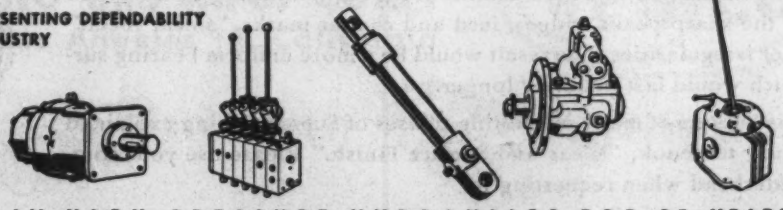
LOW COST was created as follows: (1) Availability of STANDARD, quantity-produced Blackhawk hydraulic components eliminated expense of "specials"; (2) Consultation with Blackhawk's engineering staff saved costly experimental and designing time; (3) Due to Blackhawk HIGH PRESSURE* ranges, the pump, rams, valves and oil lines are *more compact,* and hence less costly than conventional hydraulic devices intended for similar work.

SAFETY and SIMPLICITY were created by the Blackhawk hydraulic system as described on the opposite page.

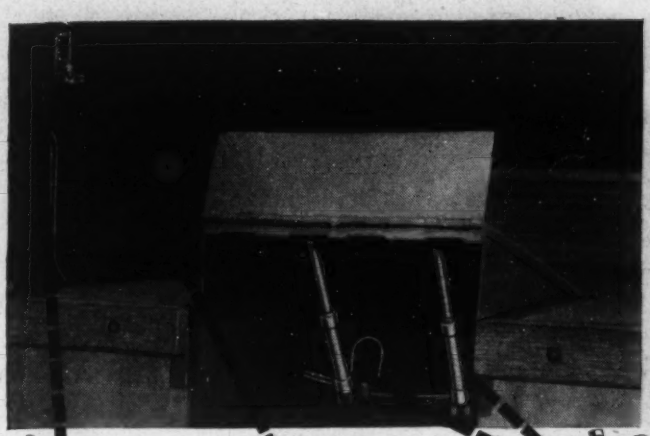
*Blackhawk specializes in engineering and manufacturing hydraulic components and systems with pressure ranges from 1,000 p.s.i. up to 10,000 p.s.i. These higher pressures create unusual benefits. Blackhawk PUMPS and VALVES (because of higher pressure capacities) are strikingly compact and RAMS have smaller diameters. The entire hydraulic system gains from (1) less weight, (2) easier installation, (3) less friction, (4) improved appearance, (5) simplicity, (6) lower cost and (7) easier service.

BLACKHAWK HYDRAULIC EQUIPPED

AN EMBLEM REPRESENTING DEPENDABILITY THROUGHOUT INDUSTRY



PIONEER SPECIALISTS IN HIGH-PRESSURE HYDRAULICS FOR 25 YEARS



A *standard* Blackhawk hydraulic pump is driven by a ½ H.P. electric motor which, with a compact oil reservoir, mount at any convenient point on the wall of the loading platform or within the building.

Two *standard* Blackhawk valves are opened simultaneously, extending the rams in unison. Each ram is checked by its respective valve—thus preventing dangerous, see-saw action when off-center loads are driven onto the ramp.

Two *standard* Blackhawk rams are mounted on a self-locating sling arrangement which is an integral part of the ramp. Thus no special on-the-job engineering is needed to install the ramp.

SIMPLE OPERATION of the valves raises or lowers this "Two-Way Loading Ramp" for positive positioning above or below the loading platform — to permit lift trucks, hand trucks, etc., to glide smoothly onto truck or car floors, regardless of their level. Installations in new or old platforms are economical.

Listen...

to what Blackhawk Hydraulic Components permit the manufacturer of the "Two-Way Loading Ramp" to say about his product:

Regarding Performance

"... after years of steady service, first installations are giving satisfactory performance with no maintenance problems."

Regarding Sales Appeal

"All of these Ramps are designed and built for safety to personnel and material as well as economy of acquisition and operation."

Sensible costs, practical design are no accident at Blackhawk...
they are born from proven Engineering and Manufacturing policies

Only with Blackhawk can you draw from a quarter-century of experience in engineering and manufacturing of high-pressure hydraulic equipment! And you get more than the invaluable benefits of high-pressures ... you also benefit from exclusive refinements built into Blackhawk components.
Comparatively, Blackhawk's PISTON-TYPE pumps furnish greater volumetric efficiencies in the higher pressure ranges—and Blackhawk offers a host of other exclusives in ram and valve designs.

"Standards" or "Specials". . . . Blackhawk furnishes components that are of standard design, continuously produced and sold in quantities for installation on products of other manufacturers. A great many manufacturers also depend on Blackhawk for specially-designed hydraulics to fit individual needs. Blackhawk has the engineering service for this work. Blackhawk products and integrated services are cataloged in profusely illustrated literature. Ask for bulletins on "High-Pressure Hydraulics," then let us counsel in confidence.

BLACKHAWK MFG. CO., 2020 S. 54th St., Milwaukee 1, Wisconsin

BLACKHAWK®

COMPLETE HYDRAULIC SYSTEMS—PUMPS (HAND AND POWER-OPERATED), VALVES AND RAMS.

To Protect Motors From Burning Out ...To Cut Costly Repairs...

USE KLIXON MOTOR PROTECTORS

Users of electric motors can be sure that they won't be troubled with burnouts if they specify and use motors with built-in Klixon Protectors. Not only will you cut motor burnouts, but you will also save money and time by practically eliminating costly repairs and replacements.

Built-in as an inherent part of the motor by the manufacturer, Klixon Protectors follow every temperature change and snap the power "off" should the motor become dangerously overheated. When the motor cools sufficiently they snap the power "on" automatically or by pushing the reset button, depending on the type of protector used. Klixon Protectors provide permanent protection . . . constantly guard the motor over its full operating life. Harmless momentary overloads do not cause nuisance tripouts.

Keep your motors and other equipment, such as transformers, solenoids, adjustable transformers, etc., operating—specify equipment with Klixon Protectors. The additional cost is low . . . pays for itself many times over by preventing burnouts, repairs and replacements.

KLIXON

HERE'S HOW KLIXON PROTECTORS OPERATE:

CLICK . . . IT'S OFF!

When temperature within the equipment reaches danger point, KLIXON Protector snaps the power "OFF" preventing burnouts.

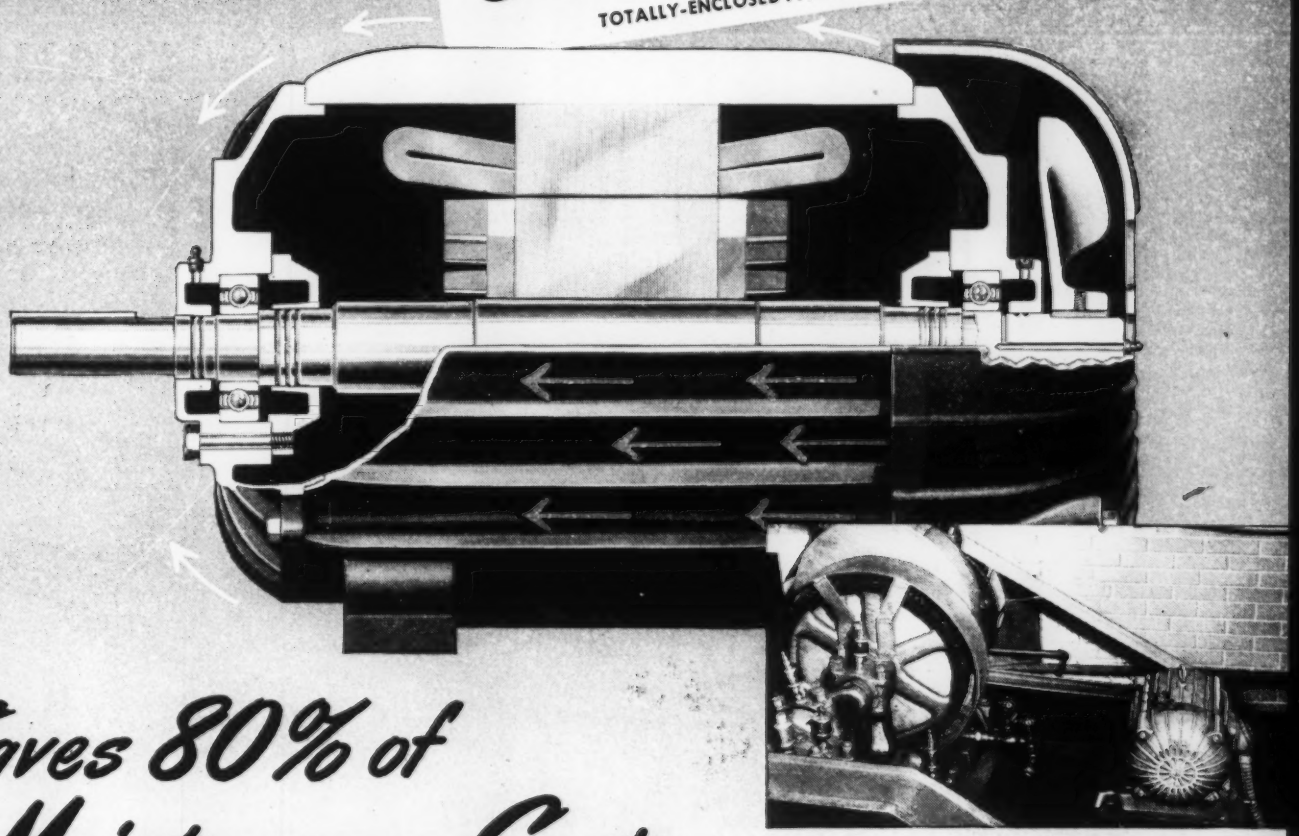
CLICK . . . IT'S ON!

As soon as equipment cools to safe operating temperature, the KLIXON Protector automatically snaps the power "ON" again . . . or by pushing the button on manual reset type.

SPENCER THERMOSTAT
DIVISION OF METALS & CONTROLS CORP.
2507 FOREST STREET, ATTLEBORO, MASSACHUSETTS

CROCKER-WHEELER *Sealedpower* MOTOR

TOTALLY-ENCLOSED . . . FAN-COOLED



Sealedpower Motor driving a vertical triplex power pump where moisture is excessive.

Saves 80% of Maintenance Costs

You can make maintenance savings of 80% and *more* with Crocker-Wheeler Sealedpower Motors. The secret? C-W dollar-saving design. No other totally-enclosed, fan-cooled motor has *exterior* cooling, with the fan-driven airstream blowing over a finned frame, carrying dust and fumes *outside* and *away*. (The outside fins that identify a Sealedpower Motor provide over 150% more cooling surface.)

But that's not all — this motor keeps cooler longer because it keeps cleaner. There's no place for lint or dirt to *collect* . . . nothing to hold heat *in*. Even on the really dirty jobs, a Sealedpower Motor will keep production going many times longer than "ventilating passage" motors, without a shutdown for cleaning.

For years of cool, clean operation and low maintenance cost, specify Sealedpower Motors. They're stock motors made for the toughest service. In new ratings from 3 to 60 hp.

Crocker-Wheeler Electric Manufacturing Company, Ampere 3, N. J. Division of The Joshua Hendy Corp., Branch Offices: Boston, Buffalo, Chicago, Cincinnati, Cleveland, Los Angeles, Milwaukee, New York, Philadelphia, Pittsburgh, San Francisco, Washington, D. C. Representatives in principal cities.

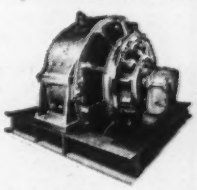
SEND FOR BOOKLET, "It's Different — it's a Dollar-Saver." Tells why the Sealedpower Motor will save money for you.

WHATEVER YOUR MOTOR REQUIREMENTS — CALL ON CROCKER-WHEELER

If Crocker-Wheeler builds it, it's a better built machine.

Horizontal and Vertical Protected-Type Induction Motors

A-C Generators and High Speed Synchronous Motors



Large D-C Motors and Generators

Turbogenerators

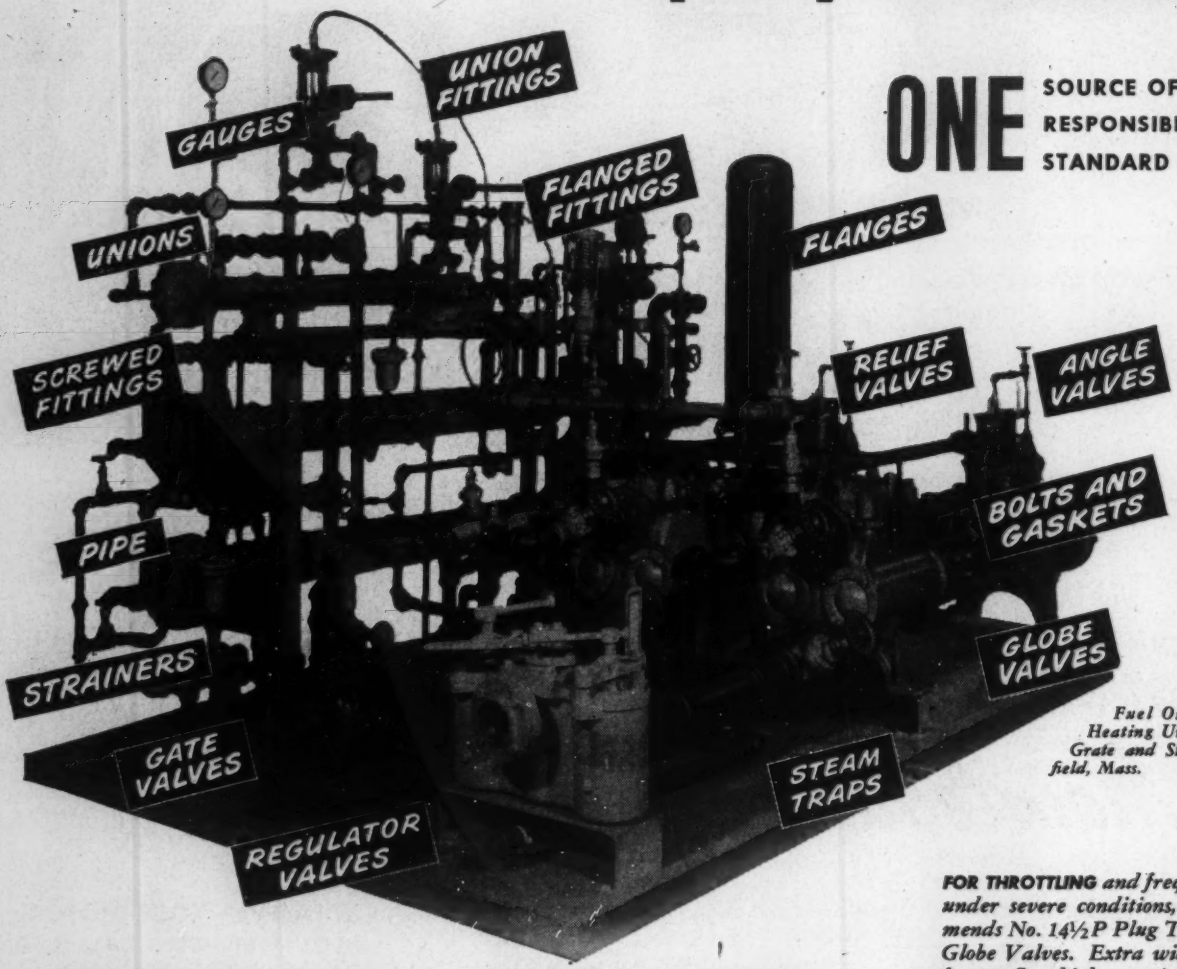
CROCKER WHEELER

ELECTRIC MANUFACTURING COMPANY, AMPERE 3, N. J.

Division of Joshua Hendy Corporation

For complete selection in piping equipment

. . . Specify the CRANE line



ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

Fuel Oil Pumping and Heating Unit by Perfection Grate and Stoker Co., Springfield, Mass.

There's no faster . . . or surer . . . way to specify the quality piping that good machine design calls for. Whether you need valves, fittings, pipe or accessories . . . you'll find them all in the Crane line.

Take This Fuel Oil Pumping and Heating Unit as an example. Every item in this particular system bears the name Crane. Regardless of the design on your boards, when you specify Crane as your **One Source of Supply**, all piping procedures—from design to finished product—are simplified.

One Responsibility for materials helps to assure better control of assembly operations in the factory; facilitates buying and storekeeping. Finally, the **High Quality** that is Crane Quality is recognized by buyers everywhere as a sign of added value.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

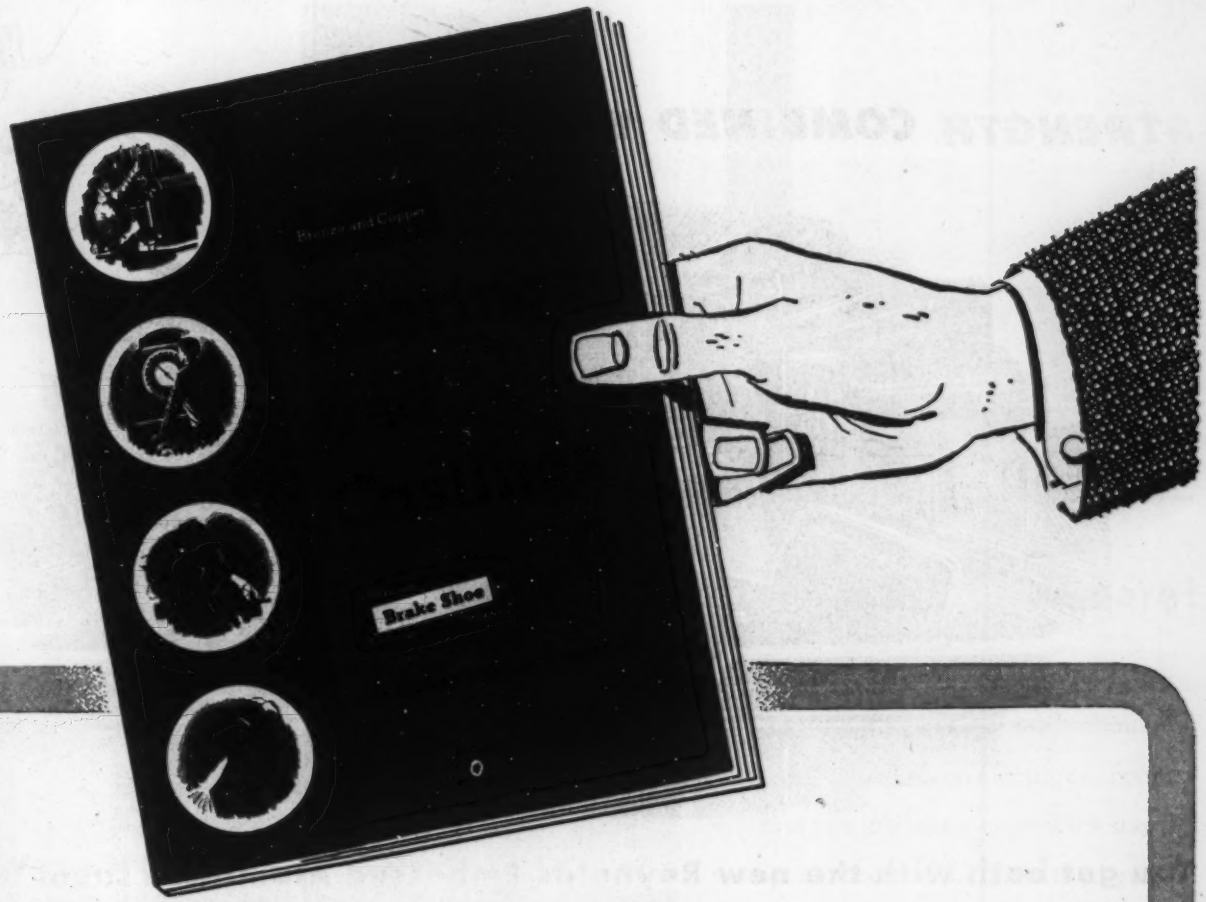
FOR THROTTLING *and frequent operation under severe conditions, Crane recommends No. 14½P Plug Type Disc Brass Globe Valves. Extra wide seating surfaces offer higher resistance to wire-drawing and foreign matter. Seating materials (Crane Nickel Alloy to Exelloy) are harder and tougher than metals ordinarily used in brass valves. Working pressures: 150-pounds steam; 300-pounds cold. Sizes: ⅛ to 3 in. See your Crane Catalog.*

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM



To those who design, specify or purchase Bronze Bearings, Castings or Babbitt Metal . . .

This NEW CATALOG was made for you

Here is a new, comprehensive catalog that will tell you how the facilities of National Bearing Division can cut costs for you and tie in with your own production.

Write for your free copy today. Use the coupon below or clip it to your letterhead for this informative, useful 28-page book which will be sent to you free of charge.

Here are some of the high points in the catalog that will interest you:

Research Facilities used in producing better Bronze Bearings and Castings.

Engineering Processes that control adherence to specifications and quality.

The latest in Foundry Techniques that are used to obtain closer grained, closer-to-size castings.

Methods used to produce precision finishes on Bearings and Castings.

Some typical products of National Bearing Division.

Bronze Bar Stock, Bronze Alloys and their physical properties.

Babbitt Metals: their proper application and physical properties.

SEND FOR YOUR *Free Copy* **TODAY**

Please send me your new book describing facilities and methods of producing Bronze Bearings, Castings and Babbit Metals.

Name..... Title.....

Company.....

Address.....

City..... State.....

Brake Shoe

NATIONAL BEARING DIVISION

4930 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

STRENGTH COMBINED WITH BEAUTY

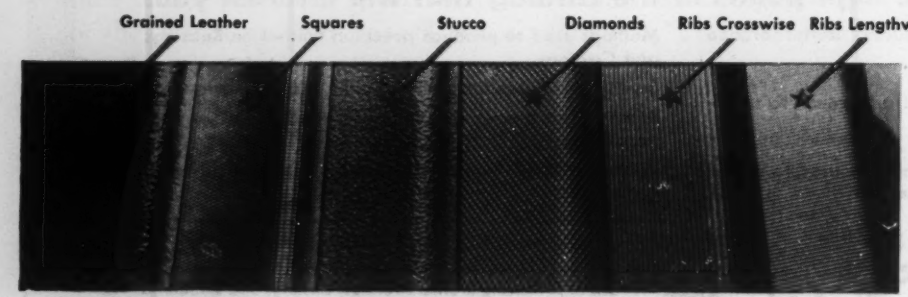
You get both with the new Reynolds Embossed Aluminum sheet finishes

● Designers' acceptance of the new Reynolds Embossed Aluminum patterns has spread rapidly—customers now acclaim it. The beauty of these smart new finishes is instantly apparent but it requires years of rugged wear to appreciate the greater rigidity, the scuff-resistant qualities embossing provides.

Above you see how three of the patterns serve in a modern motor bus interior. Ceiling is a vertical rib design; pleasing appearance and glare-reducing qualities mark its use at this point. On the dash panel a horizontal rib design adds a note of smart styling. Seat backs are protected by a diamond pattern—they take rough treatment, scuffs, dents and scratches, without showing wear. No other material serves so well, with so little maintenance, at such a low original cost.

If your product can use these new benefits without the addition of new costs, consider the range of attractive embossed patterns shown below. Remember you get a naturally pleasing finish, but it may also be painted when desirable. Scuffs and scratches are concealed by the pattern, and aluminum can be formed to modern contours, in most cases without new tool costs.

You get three times the material for production and reduced dead-weight because aluminum is ⅓ the weight of most metals. To see how your production picture can be brightened by Reynolds Aluminum, call your local Reynolds distributor or sales office listed under "Aluminum" in your classified telephone directory, or write to the address below.



FINISHES FOR ALUMINUM

Send your request for this informative book on your company letterhead and receive a copy without charge.

REYNOLDS METALS COMPANY, Aluminum Division
2521 SOUTH 3rd STREET • LOUISVILLE 1, KY.

IF YOU SEE RUST... YOU KNOW IT'S NOT ALUMINUM

REYNOLDS METALS

REYNOLDS *Lifetime* ALUMINUM

THE COMPLETE ALUMINUM SERVICE FROM BASE METAL TO FINISHED PARTS

BW

you can put a **Bruning Whiteprinter** anywhere!

BRUNING WHITEPRINTER • VOLUMATIC MODEL 93

Other Bruning Products you should know about — Drafting Machines • Sensitized Papers & Cloth • Tracing Papers • Erasing Machines • Drafting Room Furniture • Slide Rules • Surveying Instruments • many others

The modern design of a Bruning Whiteprinter makes it a self-contained unit. All it needs is an electric connection ... and you are ready to produce sharp, crisp, black-on-white prints from your tracings ... or anything typed, printed, or written or drawn in pencil or ink. Bruning Whiteprinters operate quietly. They require no plumbing connections and no ventilation ducts. Therefore they can be placed almost *anywhere* in your plant or office ... at great saving on installation costs.

Add to this the savings of time and convenience—and the fast, uniform production of Bruning Whiteprinters. Then you can see why more and more firms are turning to BW, for better prints at lower costs.

There is a Bruning Whiteprinter model for every volume of work.

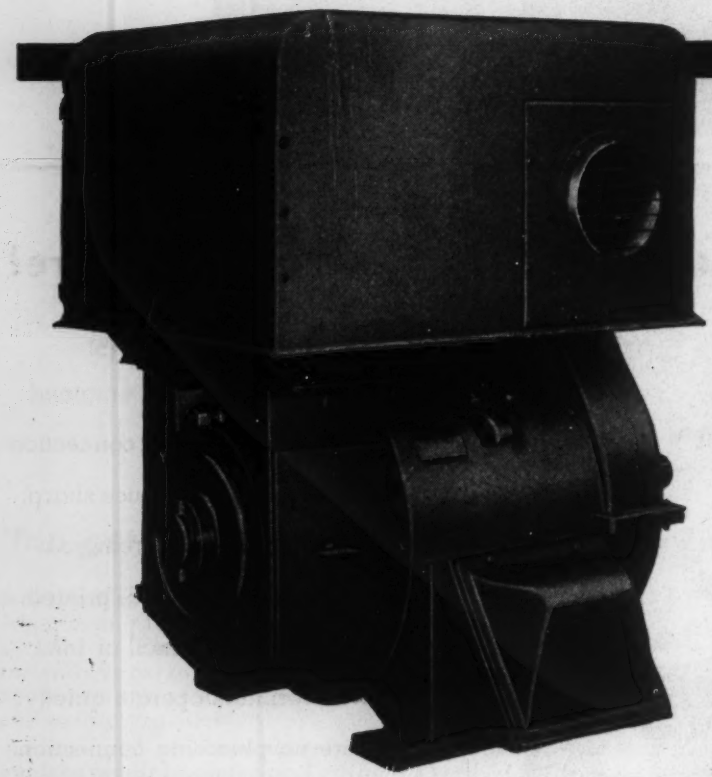
Send today for literature describing how you, too, can profit by using BW Copies. See for yourself why the BW System is the answer to your own copying needs. No obligation.

Charles Bruning Company, Inc.

4726-40 WEST MONTROSE AVENUE, CHICAGO 41, ILL.

NEW YORK • NEWARK • BOSTON • PITTSBURGH • CHICAGO • DETROIT • CLEVELAND • ST. LOUIS
MILWAUKEE • KANSAS CITY, MO. • HOUSTON • LOS ANGELES • SAN FRANCISCO • SEATTLE

Designer's



New!

UNIT-COOLED D-C MOTORS

that can't run a fever!

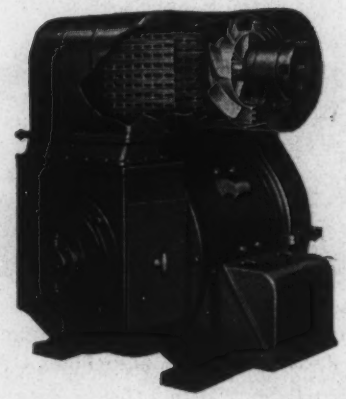
For applications where dirt, dust, or oil-laden atmospheres make it difficult to use open or partially enclosed motors, here's the newest improvement in General Electric standard, totally enclosed, unit-cooled d-c motors—ventilation entirely independent of motor speed.

In adjustable-voltage systems, these Type CD motors can be run well below full-field speeds over long periods of time and deliver full torque continuously, without danger of overheating. Full ventilation at all times is provided by a single Tri-Clad * induction motor driving two blowers at constant speed — one circulating internal air, the other external air.

Still available, to meet your limited speed range requirements, is the single-blower type. In this less expensive motor the internal cooling air is circulated by a shaft-driven fan.

With either type, no piping, ductwork, air filters or pressurized air supply are needed. Both are available in ratings from 15 to 200 hp. See Bulletin GEA-4469 for details of single-blower type; new bulletin on two-blower type will be available in a short time.

*Reg. U. S. Pat. Off.



In this cutaway illustration of the G-E single-blower unit-cooled d-c motor, note how motor air, never in contact with contaminated outside air, is cooled by flowing through passages set at right angles to the external air passages. Safe winding temperatures are maintained at all times.

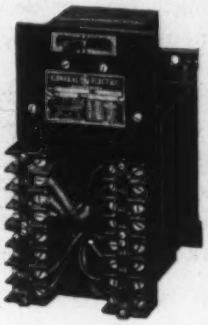
GENERAL ELECTRIC

Digest

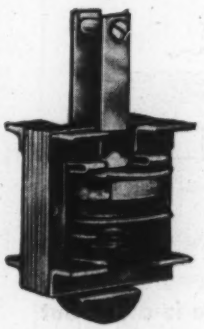
PRODUCT HIGHLIGHTS

MEETS MORE NEEDS— WITH ADDED RATINGS!

Yes, General Electric's standard line of machine-tool control transformers can now be applied to a greater variety of your designs. Five new additions have been made to the all-purpose (multi-tap primary) group, widening the available range to include ratings from 0.150 kva to 3.0 kva. These compact, versatile units save panel space, reduce inventory and storage costs, and contain built-in protection against damage from sustained overload. Many ratings are in stock, at attractive new prices.



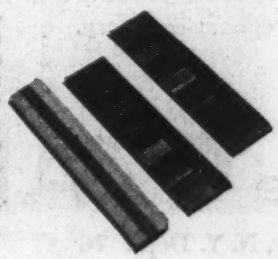
PROVIDES PUSH OR PULL— ELECTRICALLY!



Need a reliable straight-line push or pull motion in your machine? It's a precision job with G-E heavy-duty solenoids, made in a complete line for a-c or d-c. Available maximum stroke distances range from ¾-inch up to 3 inches, and thrusts from 0.65 pounds up to 97 pounds. New bulletin gives complete information on ratings, plus a section on considerations in selecting a solenoid. See Bulletin GEA-5163.

GAGES ROUGHNESS— BY "RULE OF THUMB"!

Here's a handy, simple way to test machined surfaces by feel and sight. With General Electric pocket-size roughness scales, shop men can quickly check whether finished surfaces meet your specifications. Result: time spent on unnecessarily fine finishing and rejects due to insufficient finishing are both avoided. Set includes leather case and two 6-inch metal scales divided into 24 surfaces. Available immediately. See Bulletin GEC-311.



Now—bringing you more customer goodwill

THE TRI-CLAD MOTOR EXCHANGE PLAN

You can now give your customers added assurance of operating continuity in the machines you equip with Tri-Clad motors—already the best-protected general-purpose motors money can buy. General Electric's new Tri-Clad Motor Exchange Plan relieves you of motor service responsibility, eliminates the need for you to maintain motor repair facilities. Your customer profits by extra down-time protection, lower-cost motor maintenance, and reduced spare-motor inventories.

How the plan works

If your customer's motor needs repair, his dealer or distributor exchanges it for a factory re-conditioned motor carrying a new-motor warranty—quickly, with no red tape. Inoperative motors are quickly replaced from the nearest of 16 General Electric motor-exchange centers. For full information on the plan see Bulletin GEA-5180.

General Electric Company, Section F668-74
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

( ) GEA-4469 — Unit-cooled d-c motor
( ) GEA-5163 — Heavy-duty solenoids
( ) GEA-5180 — Motor exchange plan
( ) GEC-311 — Roughness scales

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

Name.....

Company.....

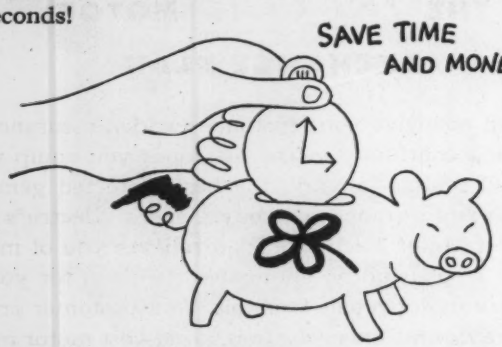
Street.....

City.....State.....

Insist on stability...
...insist on OZALID!

When you duplicate with Ozalid, you save precious time and expensive labor.

For Ozalid copies anything written, drawn, typed, or printed on translucent material in as little as 25 seconds!



When you duplicate on Ozalid, *you save still more time and labor!* You needn't waste time "learning" the characteristics of each new batch of sensitized material.

Because rigid laboratory control insures that each shipment of Ozalid material will give the same performance as the last shipment and the shipment before that.

Month after month, shipment after shipment, you'll find this constancy in speed, in density, and in color. You'll find excellent fade-resistance. Physical strength, storage life, dye density, and ease of development are kept in scrupulous balance.

Another Ozalid Advantage is the nationwide service organization at the other end of your telephone. These technically trained business wizards will keep your Ozalid operation at top efficiency, will help you work out new methods of getting more done with less work ... through Ozalid!

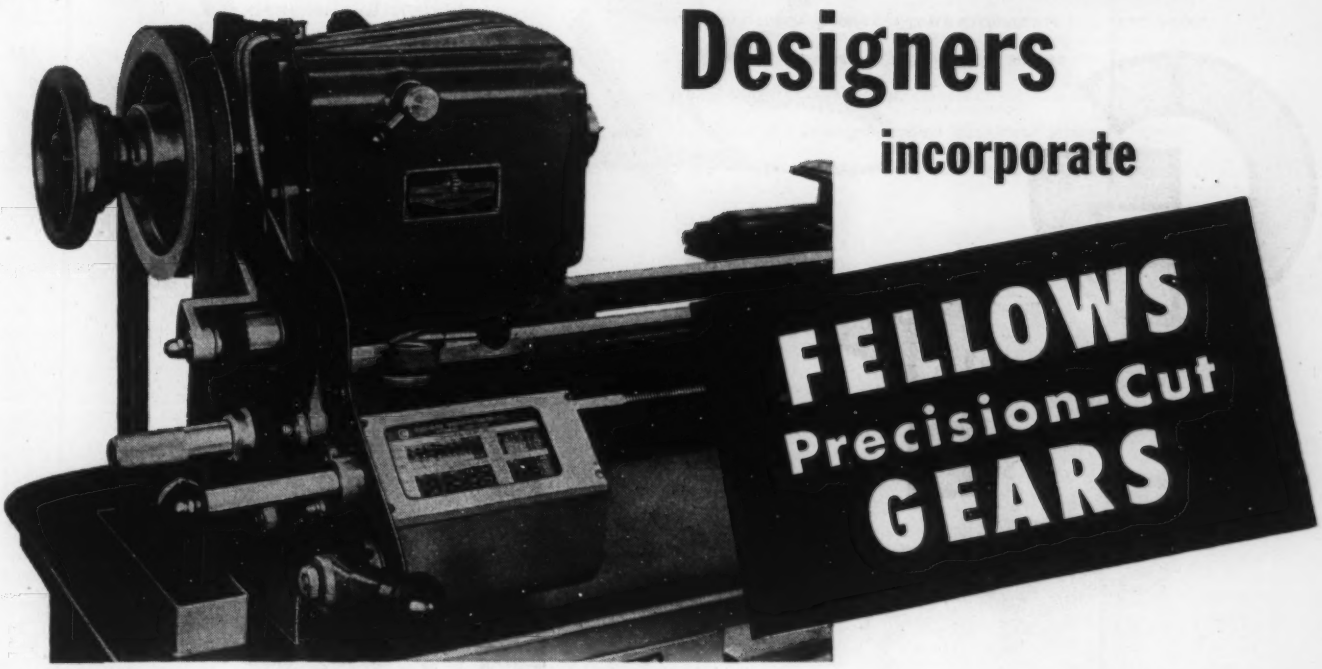
If you don't know what the above is all about ... you better hustle a letter requesting the full story of the newest business system, Ozalid. A FREE booklet explaining how error-proof Ozalid duplicates just about everything in seconds is yours for the asking. If you're too busy to write, look in your classified telephone directory.

Don't copy...use OZALID

Ozalid, Johnson City, N. Y. Dept. 76

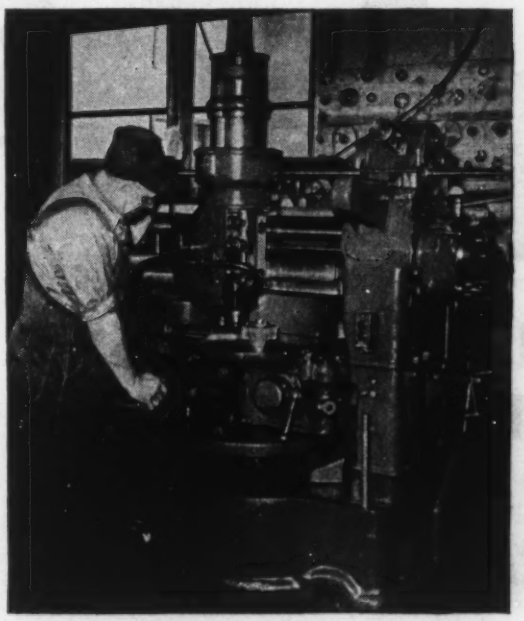
A Division of General Aniline & Film Corp. "*From Research to Reality*"

Sales-minded Designers incorporate



THE accuracy and quieter operation that accrues from precision-cut gears has long been recognized by machine designers. Now, manufacturers find that sales capital can be made of the higher-quality and greater precision of gears as generated on the Fellows Gear Shaper. Many machine tool builders for example find that Fellows-generated gearing provides a "selling plus" to their product. Savings in costs over other methods are significant, too . . . to the designer as well as the production man.

The versatility of the Gear Shaper in widening the area of low-cost generating of gears and non-gear parts should be of interest to every Sales-minded designer. As a preliminary, ask for our booklet, "The Art of Generating with a Reciprocating Tool."



Generating gears for the Clausing Precision Lathe on the Fellows 6A-Type Gear Shaper.

PHOTOS COURTESY: CLAUSING MANUFACTURING CO., OTTUMWA, IOWA

Fellows

THE FELLOWS GEAR SHAPER COMPANY

Head Office and Export Dept., Springfield, Vermont. Branch Offices: 616 Fisher Bldg., Detroit 2; 640 West Town Office Bldg., Chicago 12; 7706 Empire State Bldg., New York 1.

GEAR SHAPERS • SHAVING MACHINES • CUTTERS AND SHAVING TOOLS • GEAR INSPECTION INSTRUMENTS • THREAD GENERATORS • PLASTICS MOLDING MACHINES

Specify Grafco

FOR FLUID CONVEYING SYSTEMS, HYDRAULIC LUBRICATION, PNEUMATIC

FITTINGS, HOSE LINES & SEAMLESS STEEL PRESSURE TUBING ALL IN FULL CONFORMANCE TO JOINT INDUSTRIAL CONFERENCE HYDRAULIC STANDARDS

V. L. Graf Co.

237 E. MAIN STREET
NEW BALTIMORE, MICHIGAN

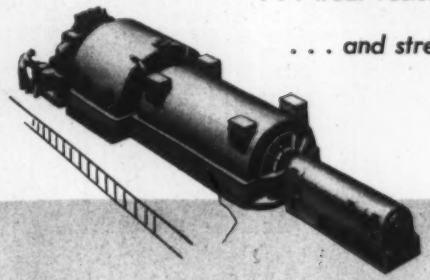
Wichita City Librar

Plastics where plastics belong

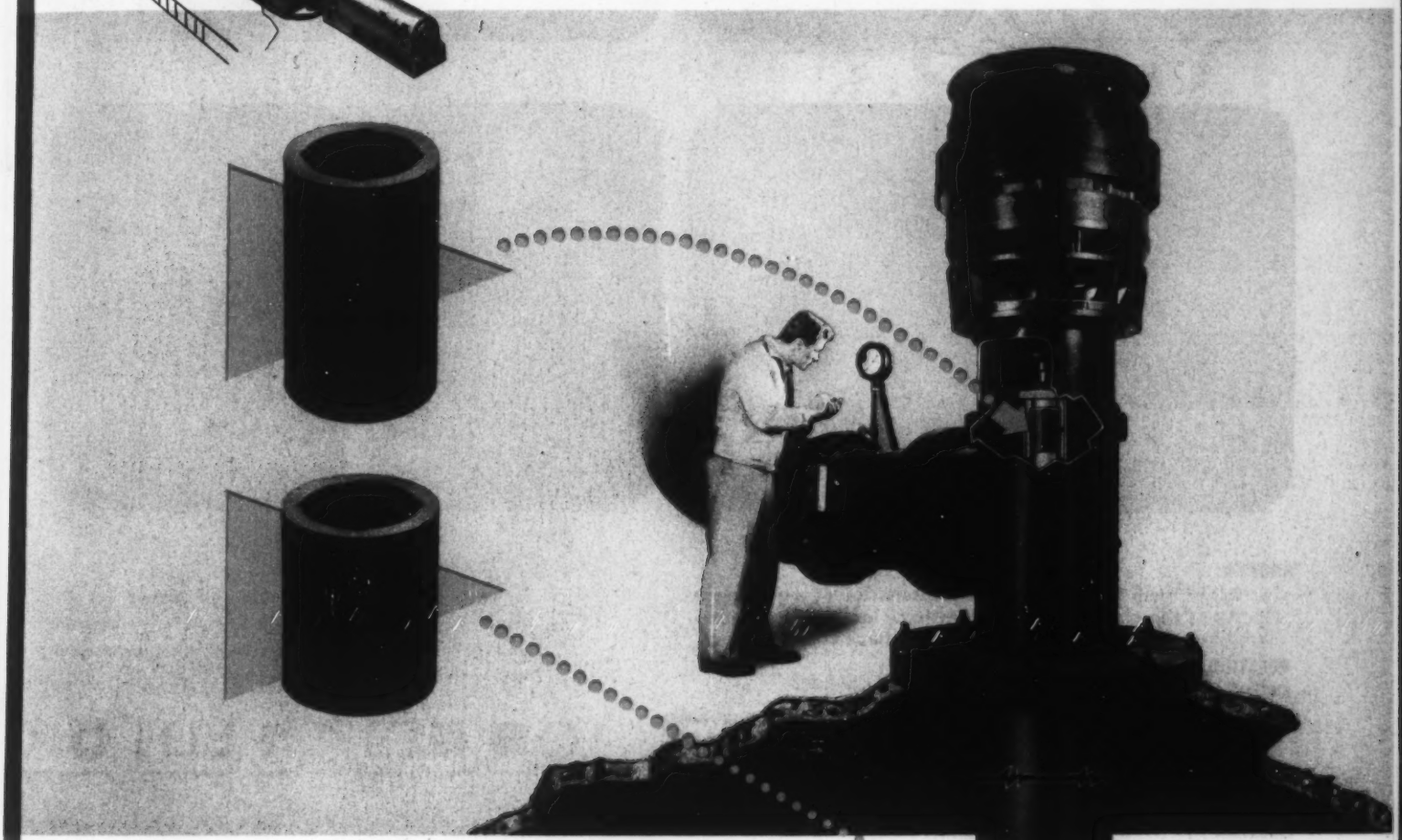
for dimensional stability

. . . wear resistance

. . . and strength

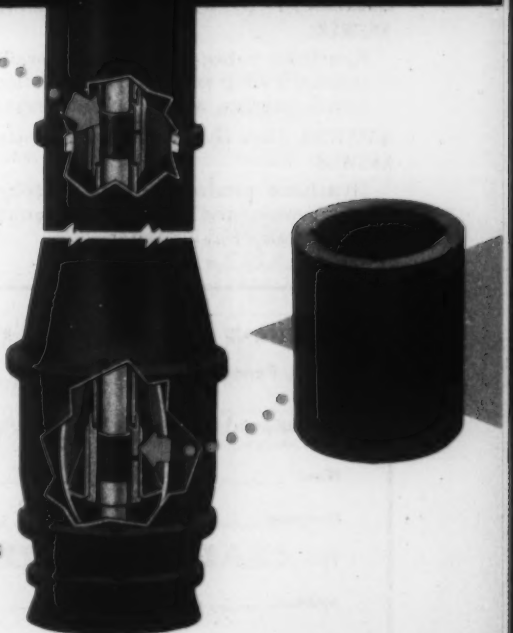


Synthane pump bearings used in this Allis-Chalmers vertical mixed flow pump illustrate an interesting application of Synthane requiring stability of dimensions within close tolerances under conditions of severe exposure to wear and water. Other interesting applications for Synthane result from its many additional properties in combination—a few of which are high dielectric strength, good structural strength, light weight, low moisture absorption, and corrosion resistance.



In the Allis-Chalmers pump shown above Synthane was selected as standard bearing material in all units pumping clear water. Tests indicated that Synthane did not swell excessively when constantly immersed in water. In these installations water is the only lubricant.

These few of Synthane's many desirable qualities may suggest its use in your products or process. If so, why not let us help with design, material, or fabricated parts. Write today for the Synthane Plastics Catalog. Synthane Corporation, 5 River Road, Oaks, Pennsylvania.



SYNTHANE *where Synthane belongs*

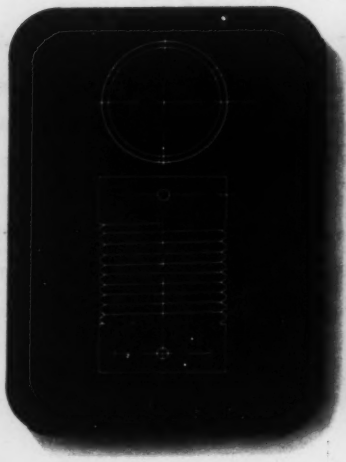
DESIGN • MATERIALS • FABRICATION • SHEETS • RODS • TUBES
FABRICATED PARTS • MOLDED-MACERATED • MOLDED-LAMINATED

Question:

What 3 points have these

7 JOBS

in common?



ANSWER:

1. All of them have an unusual combination of requirements.
2. All of them are made from Synthane laminated plastics.
3. All of them are machined from Synthane tubes or rods.

QUESTION: *What properties in combination?*

ANSWER:

Properties such as structural strength; light weight; toughness; moisture and corrosion resistance; dimensional stability; hardness; abrasion resistance; low coefficient of expansion; and desirable characteristics for electrical applications, as low power factor, high dielectric strength, low dielectric constant.

QUESTION: *Is Synthane easy to machine?*

ANSWER:

Synthane tubes and rods are easily and quickly machined by standard shop equipment, including saws, drills, lathes, millers, punch presses, and automatic screw machines.

QUESTION: *Does Synthane produce finished parts?*

ANSWER:

Synthane produces rods and tubes, helps you design for use of plastics, and delivers top quality finished parts. Send for the Tubing Folder today.

SYNTHANE CORPORATION, 5 RIVER ROAD

Oaks, Pennsylvania

Please send me the Synthane Tubing Folder by return mail

Name _____

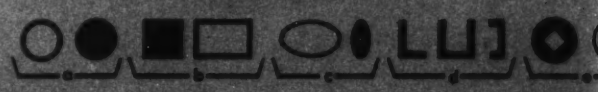
Company _____

Title _____

Address _____

City _____ *Zone* _____ *State* _____

Synthane produces a wide variety of shapes. For example: a—round tubes or rods, b—square or irregular tubes or rods, c—oval tubes or rods, d—angles or channels, e—irregular bore or insert.



Standard round tubing is always a little more economical to use, but if your needs call for an irregular shaped section, it will pay you to inquire about Synthane's diversified line of rods and tubes.

Specifications:

Diameters: Rod—⅛" to 4" O.D.
Tubing—⅛" to 22" I.D., O.D. to specifications.
(Molded tubing to 4" O.D. only.)

Lengths: 18" to 36", longer on order

Colors: Natural (Tan) or black

Finishes: Ground, buffed or varnished

For diameter or wall thickness tolerances, standards of quality for tensile and compressive strength, dielectric strength, density, percent of moisture absorption, power factor, and dielectric constant, write for descriptive Tubing Folder.

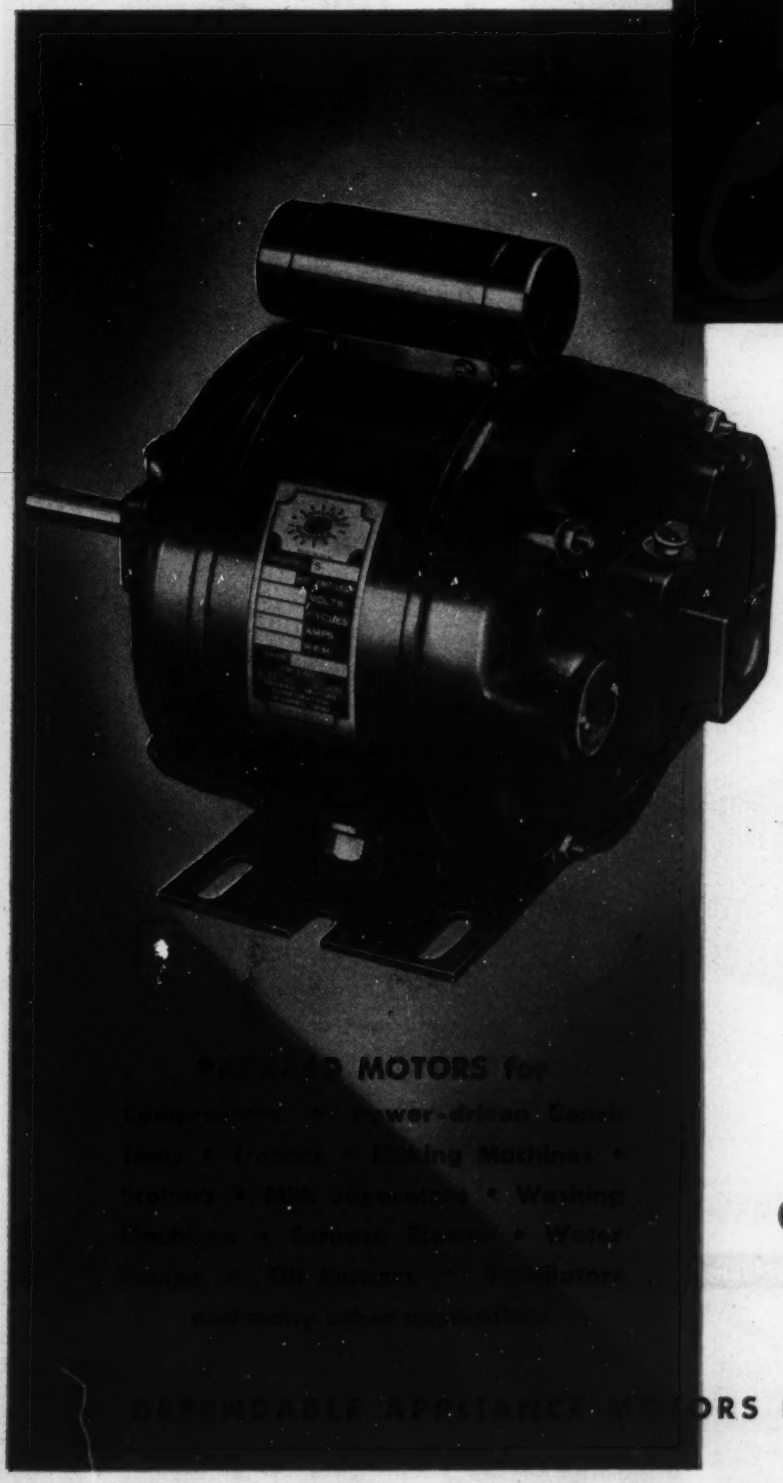
SYNTHANE

SYNTHANE CORPORATION • OAKS • PENNSYLVANIA

Representatives in ALL Principal Cities

For fractional horsepower motors come to headquarters!

PACKARD SUNLIGHT MOTORS



Our entire motor-building facilities are devoted to the production of fractionals. Our entire motor-building experience—experience which spans 33 years—has been in the fractional horsepower motor field.

And so we feel we are entitled to designate our fractional-horsepower motor-building operations as "headquarters" . . . and to write "specialists" after our name.

If your fractional motor requirements call for quality in quantity, we will be glad to have our engineers consult with you.

GM GENERAL MOTORS

Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division, General Motors Corporation
Warren, Ohio

RS FOR THIRTY-THREE YEARS

Steel-Weld FABRICATION

Regardless of what your welded steel requirements may be, regardless of design, size or weight, Mahon engineering, production, and machining facilities, backed by craftsmen highly skilled in the welding art, assure you a better, smoother appearing job, embodying every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY
DETROIT 11, MICHIGAN

Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON

...ONE OF FOOTE BROS. COMPLETE LINE!

Hygrade enclosed gear drives

This famous line of worm gear drives has been newly engineered to offer the maximum in heavy-duty service and rugged dependability. These units now possess greater overhung load capacities.

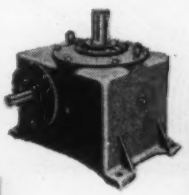
Advanced methods in manufacture make possible new refinements in both worm and gear which assure extreme precision in the development of mating surfaces with a flawless finish. This gives longer life, smoother operation, quieter service.

Hygrade Drives are available in both horizontal and vertical types. Single reduction ratios up to 71 to 1, capacities up to 125 h.p. Double reduction (helical-worm and double-worm) with ratios from 50 to 1 up to approximately 4000 to 1, capacities up to 50 h.p.

AVAILABLE FROM STOCK

Foote Bros. Hygrade Drives in more popular sizes and ratios are available from stock. Write for information.

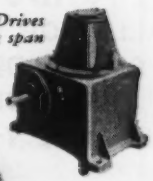
Hygrade Horizontal Drive

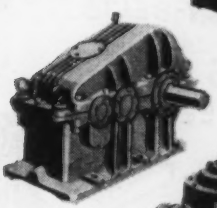


Hygrade Vertical Drives.

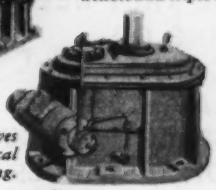
Hypower Drives bring new compactness in design, lower original cost, lower operating cost, through increased thermal capacity.

Hygrade Top Hat Drives have wider bearing span in the unit, permitting greater unsupported loads.





Maxi-Power Helical Gear Drives, available in single, double and triple reductions.



Agitator Drives combining helical and worm gearing.

Straight Line Drives. Designed for long life and quiet operation. Large overhung load capacities.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard, Chicago 9, Illinois

Foote Bros. Gear and Machine Corporation
Dept. O, 4545 South Western Boulevard
Chicago 9, Illinois

Gentlemen:
Please send me information on drives checked below.

- ☐ Hygrade Enclosed Worm Gear Drives
- ☐ Hypower Enclosed Worm Gear Drives
- ☐ Maxi-Power Enclosed Helical Gear Drives
- ☐ Agitator Drives
- ☐ Straight Line Enclosed Gear Drives

V-Belts can do the darndest things!

MAKE A SWEATER- MAKING YARN FOR KNITTED GOODS CALLS FOR STEADY, EVEN TENSION, LEST SUDDEN SHOCKS BREAK THE SLENDER STRANDS. TEXTILE MACHINE MAKERS USE V-BELTS.

WHY V-BELTS? BECAUSE THEY CUSHION SHOCKS. ABSORB THEM IN THE PULLEY GROOVES. THEY START AND STOP SMOOTHLY TRANSMIT POWER EVENLY.

GRIND HAMBURGER- GRINDING MEAT CALLS FOR POWER SUPPLY THAT IS CLEAN, DEPENDABLE, COMPACT. GRINDER MANUFACTURERS USE V-BELTS.

WHY V-BELTS? BECAUSE THEY NEED NO OILING OR LUBRICATING. THEY LAST LONGER, SAVE SPACE. CAN CUT TRANSMISSION DISTANCES AS MUCH AS 5 TO 1.

CUT THE GRASS- POWER MOWER MANUFACTURERS USE V-BELTS TO REDUCE GRASS CUTTING TO A WALK AROUND THE YARD.

WHY V-BELTS? BECAUSE THEY ARE EFFICIENT, INEXPENSIVE AND PROTECT PARTS BY ABSORBING SUDDEN SHOCKS. THEY SIMPLIFY MAINTENANCE, ARE CHEAP TO BUY, EASY TO REPLACE.

What have you done?

Here are just three examples of how Design Engineers have used V-Belts to solve power transmission problems. How about you? Have you used them in your work? If you have, we'd like to share your application with your fellow Engineers. Write and tell us about it. We'll be glad to publish it, giving you full credit, of course.

What would you like to do?

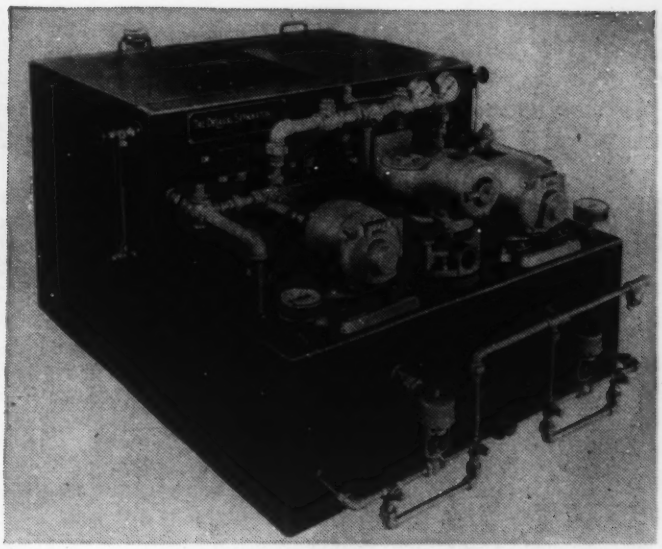
V-Belts have the happy faculty of making power drives more efficient, or easier to maintain, or quieter, or cheaper.

Dayton has built millions of them—for every kind of use, speed or driving condition. And our Engineers are completely skilled in how to use them. Write us your problem. We'll be happy to help you solve it. *Dayton Rubber Co., Dayton 1, Ohio.*

Dayton Rubber

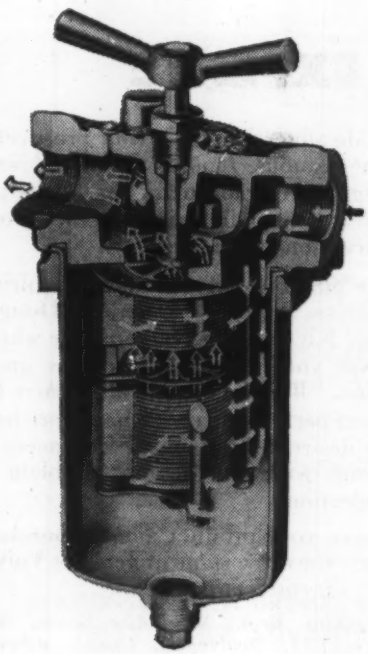
THE MARK OF TECHNICAL EXCELLENCE IN NATURAL AND SYNTHETIC RUBBER

DeLaval Separator Company uses Cuno AUTO-KLEAN filters to condition for reuse the oil in its pressure lubricating systems. Single motor-driven cartridge, built into the unit, continuously removes contaminants from full flow of recirculating oil . . . with no stops for filter-cleaning.



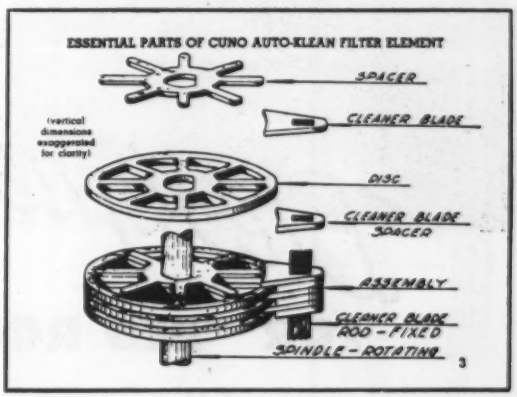
Non-stop Laundry Service

for Lubricating Oils



Single compact unit—no larger than usual partial-flow type—handles full flow of practically any fluid. Filtering element is permanent, all-metal, disc-type cartridge.

● Your nearby Cuno engineering representative, handling the broadest line of fluid filters, is your best source of unbiased recommendations on fluid filtration . . . he offers you, before and *after* installation, service based on years of experience with engineering filtration systems.



Continuously cleanable feature permits single unit installations. Can be cleaned periodically by hand or continuously by motor drive, without shutting down operation.

Built-in or Externally Mounted

Cuno Auto-Klean Filters are available for built-in or external installations, in sizes handling from a few to more than 4000 gpm.

Send Coupon

FOR FREE INFORMATION ON CUNO CLEANING

CUNO

Fluid Conditioning

Removes More Sizes of Solids from More Types of Fluids

MICRONIC • DISC-TYPE • WIRE-WOUND

Cuno Engineering Corporation
204 S. Vine St., Meriden, Conn.

Please send information on Cuno Filter.

Name.....

Position.....

Business Address.....

PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

FOR "BED ROCK" SERVICING EXPENSE

IN ANY PRODUCT where fluid control is a function of operation, unsatisfactory performance can often be traced to valves. Continuous, costly servicing quickly wipes out "savings" made by using inferior valves, cuts into profits . . . may give an otherwise fine product a "black eye."

Trouble-free performance can be designed into your product — by specifying Jenkins Valves. If you choose the right Jenkins Valves for the service, and locate them correctly, you can rest assured of bed rock valve servicing costs, even under the toughest conditions.

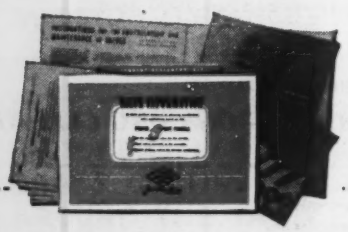
You also profit by Jenkins long experience in supplying valves for all types of products. You add the valve know-how of Jenkins Engineers, whenever necessary, to your own designing skill.

Most important, you gain a definite sales advantage by enlisting the established customer-confidence in Jenkins Valves, built up over 83 years by providing *extra value* in valves, and by continuous industry-wide advertising. To your prospects, the famous Jenkins Diamond and Signature trade mark on valves indicates equally high quality construction throughout.

In planning any product requiring valves, use the new Jenkins Designers' Kit. It will save you time whenever you need to answer the question, "*Which* type of valve *where* for best performance?" When more help is desired, ask Jenkins Engineers to work with you on any problem of selection.

Give your product and its purchasers, the *extra value* of Jenkins Valves . . . *it costs no more.*

Jenkins Bros., 80 White Street, New York 13; Bridgeport, Conn.; Atlanta; Boston; Philadelphia; Chicago; San Francisco. Jenkins Bros., Ltd., Montreal.



GET JENKINS DESIGNERS' KIT. A handy file of valve information needed by product development men . . . helps answer the question — "Which type of valve where for best performance?" Mail the coupon.

JENKINS BROS., 80 White St., New York 13

Please send me the Jenkins Designers' Kit.

Name.....

Company.....

Address.....

LOOK FOR THIS DIAMOND MARK

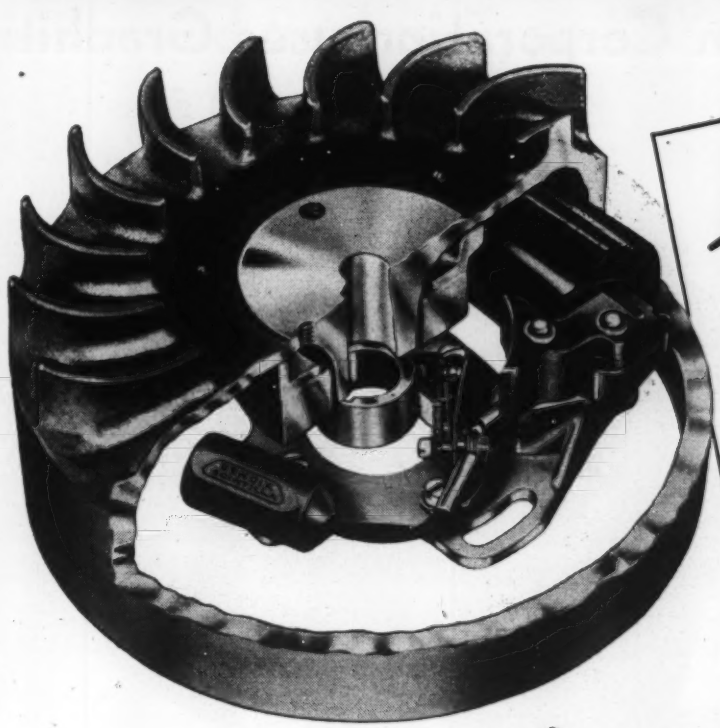
SINCE 1864

JENKINS VALVES

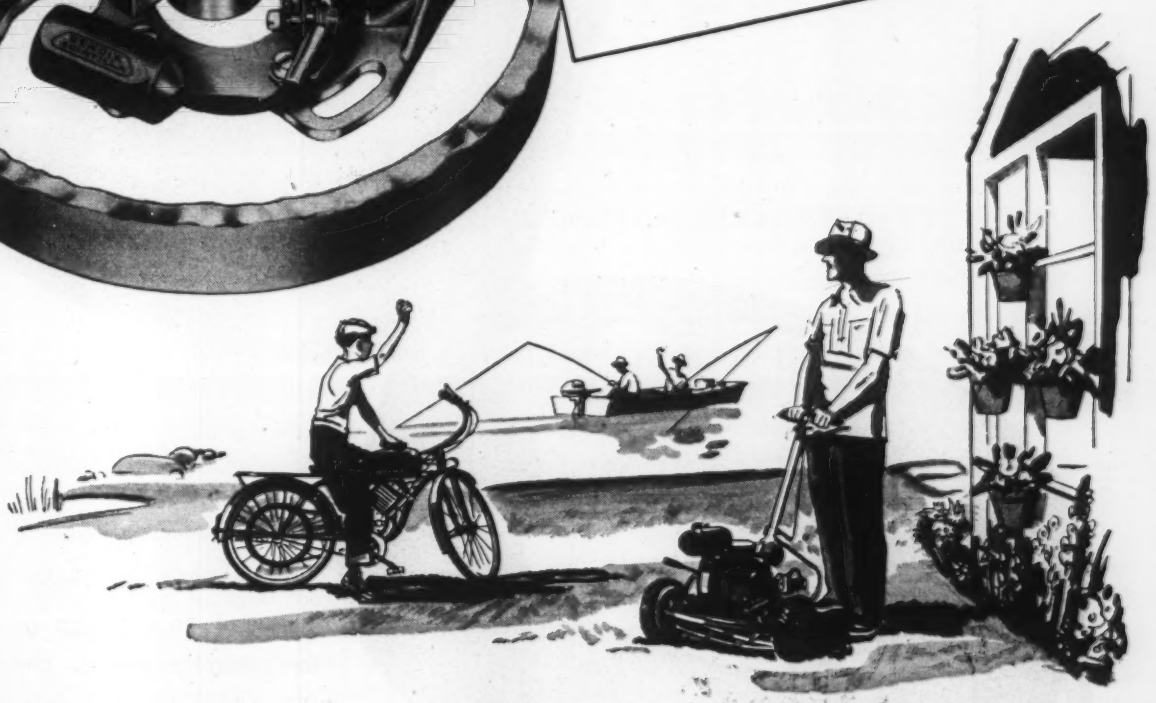
Types, Sizes, Pressures, Metals for Every Need

BENDIX-SCINTILLA FLYWHEEL-TYPE MAGNETO

FOR 1- AND 2-CYLINDER ENGINES



Hotter Sparks at Low Speed



BENDIX-SCINTILLA BRINGS YOU ALL THESE OTHER ADVANTAGES

Molded condenser . . . Lower operating cost . . . Minimum lubrication requirements . . . Waterproof molded coil . . . Peak efficiency at high or low speeds . . . Light in weight.

More and more manufacturers and users of small industrial engines are specifying the Bendix-Scintilla Flywheel-type Magneto. Why? Because the low coming-in speed of this magneto, plus its other operating features, makes possible strong, constant ignition with a bare minimum of speed. Outboards, power mowers, and motor bikes alike get efficient sparks at low speeds—an important contribution to instant starts and dependable engine operation. Only Bendix-Scintilla gives you the benefit of twenty-five years' experience in building fine ignition systems for aircraft engines.

For Further Details and Suggested Applications,
WRITE DIRECT TO THE SALES DEPARTMENT

BENDIX SCINTILLA

SCINTILLA MAGNETO DIVISION of
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

graphitar

(CARBON-GRAPHITE)

problem in rotary pressure

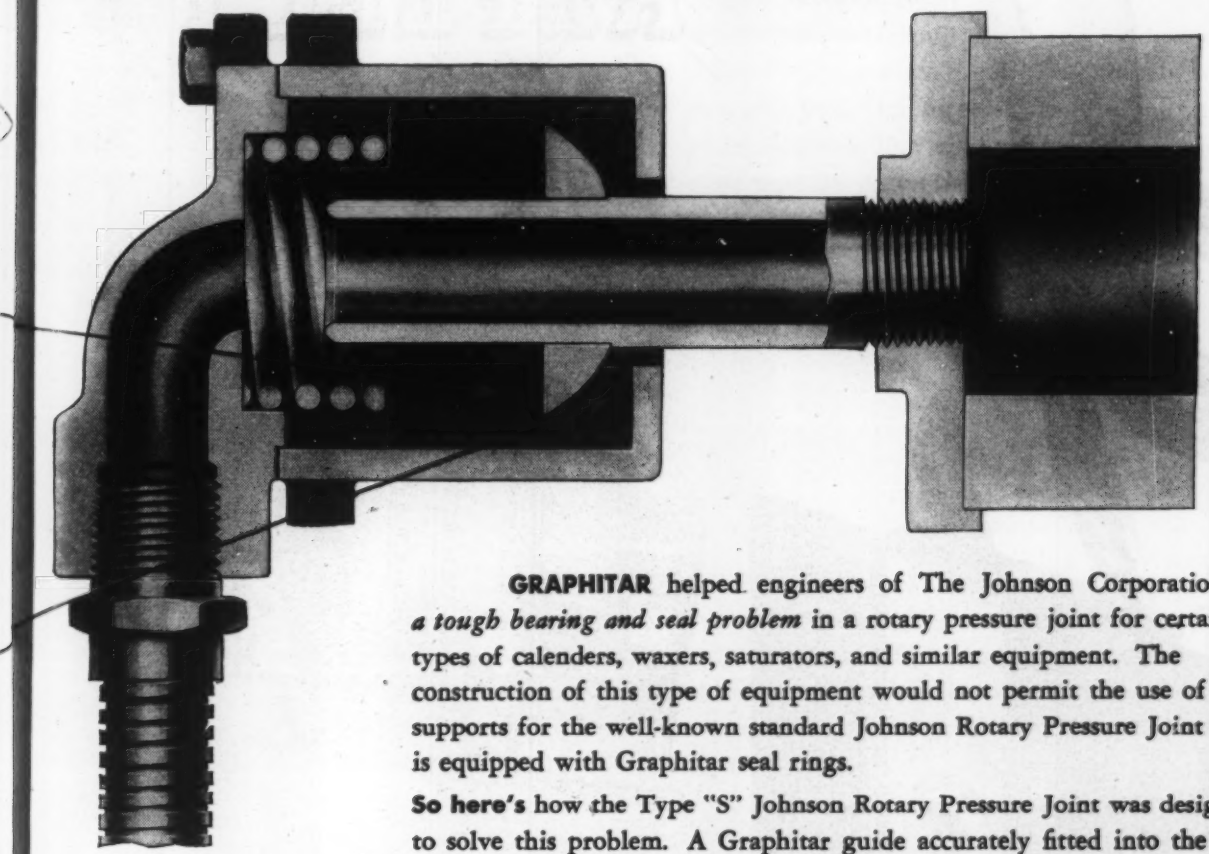
the Johnson Corporation uses Graphitar

GRAPHITAR may hold the answer to one of your design problems. It is mechanically strong, chemically inert, and highly resistant to wear. It is virtually unaffected by temperature extremes, it's self-lubricating, and extremely light weight. We can mold Graphitar in *a variety of shapes and sizes and finish it to tolerances as close as .0005" in small sizes.* Send us sketches or prints of your products and our engineers may show you where Graphitar will improve mechanical performance and save you money. **Ask for our new 64 page Catalog just released.**

THE UNITED STATES GRAPHITE COMPANY

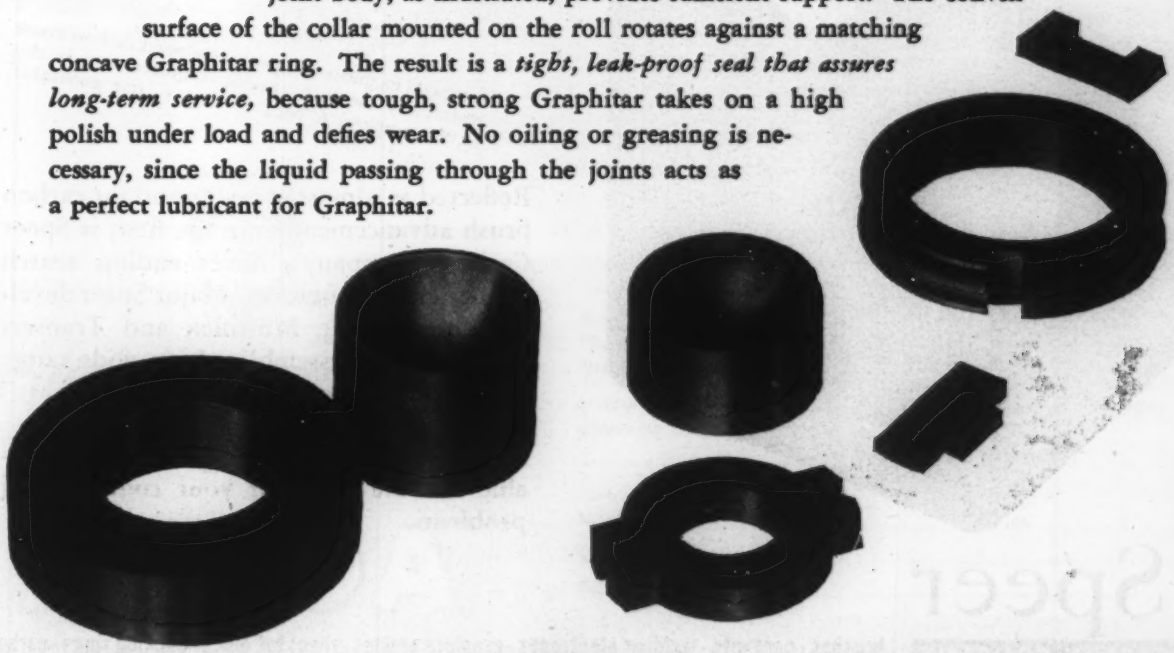
provides answer to design joint

Guide and Seal in Type "S" joint



GRAPHITAR helped engineers of The Johnson Corporation *lick a tough bearing and seal problem* in a rotary pressure joint for certain types of calenders, waxers, saturators, and similar equipment. The construction of this type of equipment would not permit the use of supports for the well-known standard Johnson Rotary Pressure Joint which is equipped with Graphitar seal rings.

So here's how the Type "S" Johnson Rotary Pressure Joint was designed to solve this problem. A Graphitar guide accurately fitted into the joint body, as illustrated, provides sufficient support. The convex surface of the collar mounted on the roll rotates against a matching concave Graphitar ring. The result is a *tight, leak-proof seal that assures long-term service,* because tough, strong Graphitar takes on a high polish under load and defies wear. No oiling or greasing is necessary, since the liquid passing through the joints acts as a perfect lubricant for Graphitar.

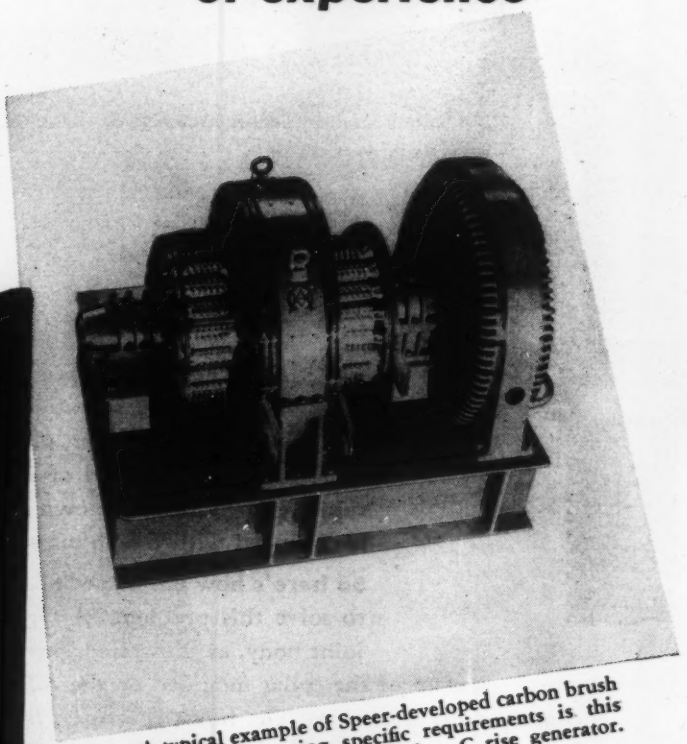


DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

Speer carbon brushes

REFLECT

50 years of experience



A typical example of Speer-developed carbon brush assemblies meeting specific requirements is this 15,000 ampere, 6 volt, 40 deg. C rise generator.

Reflected in almost every important carbon brush advancement since the first, is Speer Carbon Company's never-ending search for better commutation. Major Speer developments include Multiflex and Transert design—brush assemblies for a wide range of jobs.

Speer's half-century of experience is available for the study of your commutating problems.

Speer

CARBON COMPANY
ST. MARYS, PENNA.

brushes • contacts • welding electrodes • graphite anodes • rheostat discs • packing rings • carbon parts

CHICAGO • CLEVELAND • DETROIT • MILWAUKEE • NEW YORK • PITTSBURGH

10,000 . . . 20,000 . . . 30,000 rpm. You can almost feel the stresses build up. Be thankful if rotating parts are Alcoa Forgings. Their aluminum *lightness* cuts centrifugal stresses in half. Their forged *strength* fights failure. Their *uniformity* makes performance predictable.

Add corrosion resistance, fast heat transfer, easy machinability . . . and you'll see why designers pick Alcoa Forgings when the specs are tough. It's worth investigating. Our forge shops are ready to tackle your problem. Just mail the coupon below. Or call your near-by Alcoa Sales Office.

ALCOA

Aluminum Forgings by

ALCOA

ALUMINUM COMPANY OF AMERICA
1940-G Gulf Building
Pittsburgh 19, Penna.

I would like to have full information on the advantages of aluminum forgings for the following application:

_____

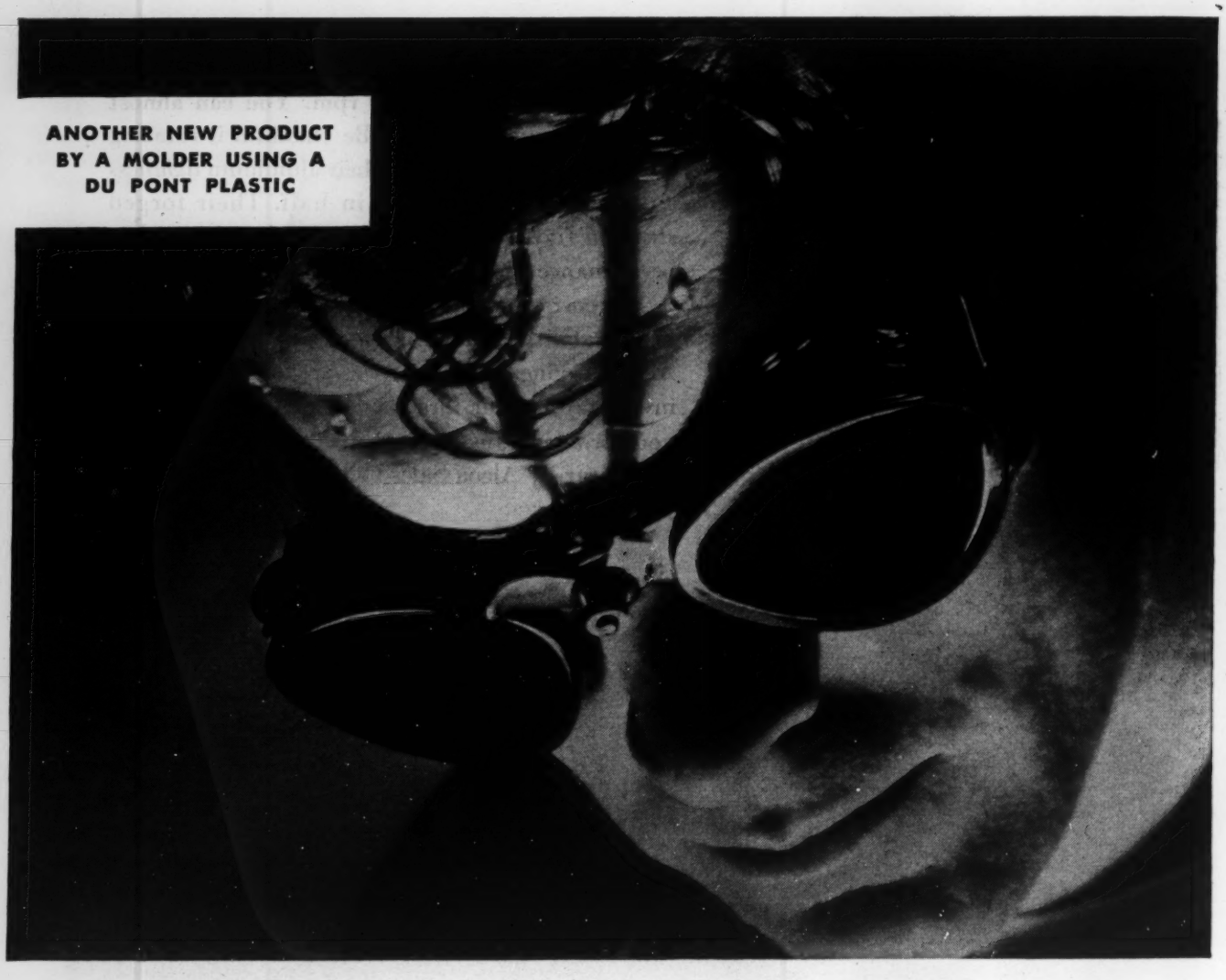
_____

Name_____ Position_____

Company_____

Address_____

ANOTHER NEW PRODUCT BY A MOLDER USING A DU PONT PLASTIC



WHY NYLON PLASTIC FOR SAFETY GOGGLES?

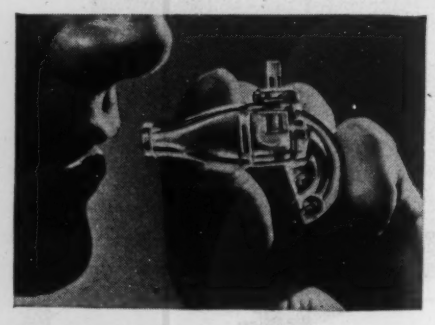
A flying spark or metal chip . . . a machine run amuck . . . a squirt of acid. Such mishaps can cause serious eye injuries to welders and other plant workers.

To give workers' eyes the greatest possible protection . . . protection far beyond ordinary requirements . . . one manufacturer set out to produce a super-strong, light-weight safety goggle. In addition to extra-durable lenses, he needed eye cups to withstand the hardest blow and resist heat and perspiration. They had to be light in weight and comfortable to wear. After studying various materials, the manufacturer found *the* material for the job in tough molded Du Pont nylon.

Nylon, he found, has great compressive strength . . . high impact resistance. Even after being squeezed in a vise, the nylon cups snap back to normal shape. These goggles are molded to fit facial contours with comfort, fitted with tough lenses. According to the manufacturer, these goggles will last a lifetime . . . give the worker better eye safety than any previous goggle.

The advantages of nylon, as well as those of other plastics in the Du Pont family, may help you improve your own products or design new ones. It's easy to get all the facts. Write E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, 350 Fifth Ave., New York 1, N. Y.; 7 S. Dearborn St., Chicago 3, Ill.; 845 E. 60th St., Los Angeles 1, Calif.

Safety goggles made by Willson Products, Inc., Reading, Pa.



WHAT'S NEW . . . For penicillin powder inhalation, this "Aerohalor"* is made of Du Pont "Lucite"* acrylic resin by Abbott Laboratories, North Chicago, Ill. Abbott uses "Lucite," because it doesn't cause deterioration of penicillin, looks attractive, is easy to clean and resists breaking. "Lucite" also is odorless, tasteless, non-toxic and pleasant to the touch. *REG. U. S. PAT. OFF.

DU PONT
REG. U.S. PAT. OFF.
Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Only FORGINGS Offer So Many Sure Fire Ways to Obtain Lower Costs At The Point of Assembly

Macro-etch cross-section of Steering Lever forging shows how density of grain structure insures safety in operation of trucks and busses.

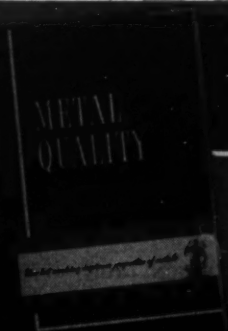
The maker of a Disc Clutch embodying this forged steel actuating lever increased the rate of machining two and one half times by having it forged.

A weight reduction of 22 per cent and a considerable saving in machining and finishing time was obtained by forging this Clutch Yoke used with an air-cooled gasoline engine.

This Sprocket forging weighs 18 lbs. less than the bar stock formerly required to produce it. Maker reports 40 per cent saving in machining and finishing time as result of forging to shape.

There are thousands of instances where forgings have reduced the cost of parts at the point of assembly. Forgings provide qualities and economies that are otherwise unobtainable. Forgings provide rapid assembly of complex parts by welding adaptability of widest range. Forgings permit reduction of dead weight because maximum strength and toughness are obtainable in lighter sectional thicknesses. Forging to shape avoids waste of metal and reduces machining and finishing time-cost. Forgings provide the strength and toughness for unrelenting and uninterrupted performance. The metal quality and cost-reducing possibilities obtainable in forgings cannot be duplicated. Recheck every stressed part in your equipment, as well as simple handles and levers, and consult a Forging Engineer about the possibilities for reducing parts' costs at the point of assembly. Only a Forging Engineer can inform you fully regarding the numerous advantages obtainable with forgings.

DROP FORGING ASSOCIATION



A REFERENCE BOOK ON **FORGINGS** FOR ALL USERS OF METAL PARTS

DROP FORGING *Topics* ISSUED 6 TIMES A YEAR

DROP FORGING ASSOCIATION
605 HANNA BUILDING • CLEVELAND 15, OHIO

☐ Booklet on "Metal Quality—How Hot Working Improves Properties of Metals"

☐ "Drop Forging Topics" which presents numerous end use applications of forgings.

Name_____ Position_____

Company_____

Address_____ City_____ State_____

6 OPERATIONS ELIMINATED

when they changed to Carpenter Stainless Tubing...

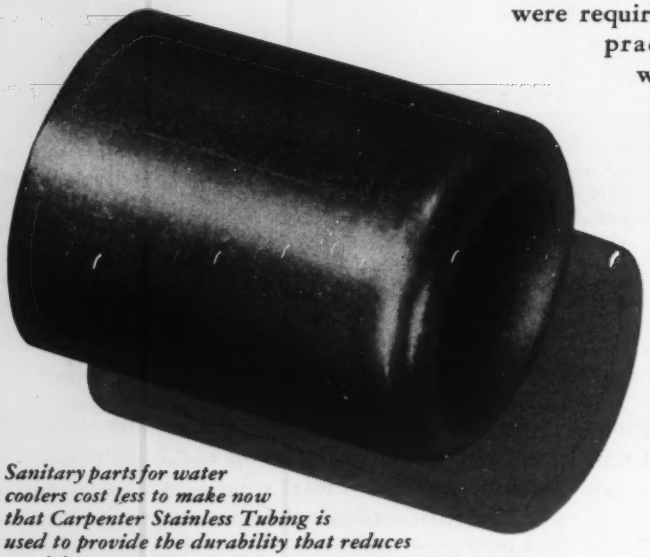
This job is exceptional, but it shows what *can* happen to unit costs when you make use of Carpenter's experience with Stainless Tubing.

Unit costs were way out of line and rejects were piling up on the floor when this water cooler part was made from sheet. Seven operations were required on each part. Silver soldering of finished units was practically impossible because the fabricated material would not satisfactorily withstand high temperatures.

Now, water cooler parts are fabricated in one reverse bending operation from Type 304 Carpenter Stainless Tubing. Six operations, ranging from the slitting of sheet to the annealing of fabricated parts, have been eliminated and the soldering of assemblies is a snap.

To find ways to save time and reduce unit costs on your own jobs, put our Stainless Tubing experience to work. It will cost you nothing and may save you plenty.

THE CARPENTER STEEL CO.
Alloy Tube Division • 115 Springfield Road • Union, N. J.



Sanitary parts for water coolers cost less to make now that Carpenter Stainless Tubing is used to provide the durability that reduces servicing costs.

NEW FILE FOLDER OF DATA ABOUT STAINLESS TUBING

For useful information about physical properties, heat resistance characteristics, standard sizes, etc., write on your company letterhead and ask for the 12-page Carpenter Stainless Tubing Data File Folder.

24-Hour Service On Your Orders...

You get definite delivery information within 24 hours when you call your Carpenter Stainless Tubing Distributor.

Carpenter

STAINLESS TUBING

"MORE THAN CORROSION RESISTANCE"

New TIMKEN®
"Double-Zero" bearing has run-out reduced by half!

Production being increased to meet growing demand

ONE industry after another is setting new standards of accuracy by equipping precision machinery with the new Timken® "Double-Zero" bearings. Maximum run-out tolerance—standard of bearing accuracy—is only 75 millionths of an inch in the "Double-Zero" bearing—half that of the Timken "Zero" bearing which had long been the most accurate Timken bearing on the market.

This amazingly low run-out already is proving invaluable in bringing increased precision to grinding machine spindles, small precision rolling mills, lathe spindles, dividing heads, and gear cutting machines. And production of the "Double-Zero" is being increased to meet the growing demand.

If you make a product that can benefit from greater bearing precision, you'll want to learn more about the new Timken "Double-Zero" bearing. It is produced in the sizes and types indicated in the chart below. For further information write The Timken Roller Bearing Company, Canton 6, O. Cable address: "TIMROSCO".

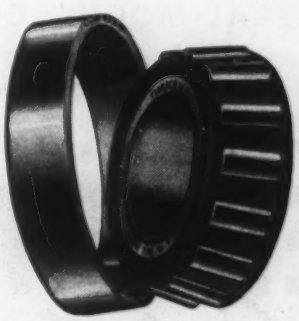
This symbol on a product means its bearings are the best.

A PRECISION TIMKEN BEARING FOR EVERY REQUIREMENT			
CLASS	**"00" (DOUBLE-ZERO)**	**"0" (ZERO)**	**"3" (THREE)**
RUN-OUT	.000075"	.000150"	.000300"
TYPES AVAILABLE	Standard Single Row	Standard Single Row	All types
SIZE RANGE	Up to 10" O.D.	Up to 12" O.D.	Up to 12" O.D.

TIMKEN

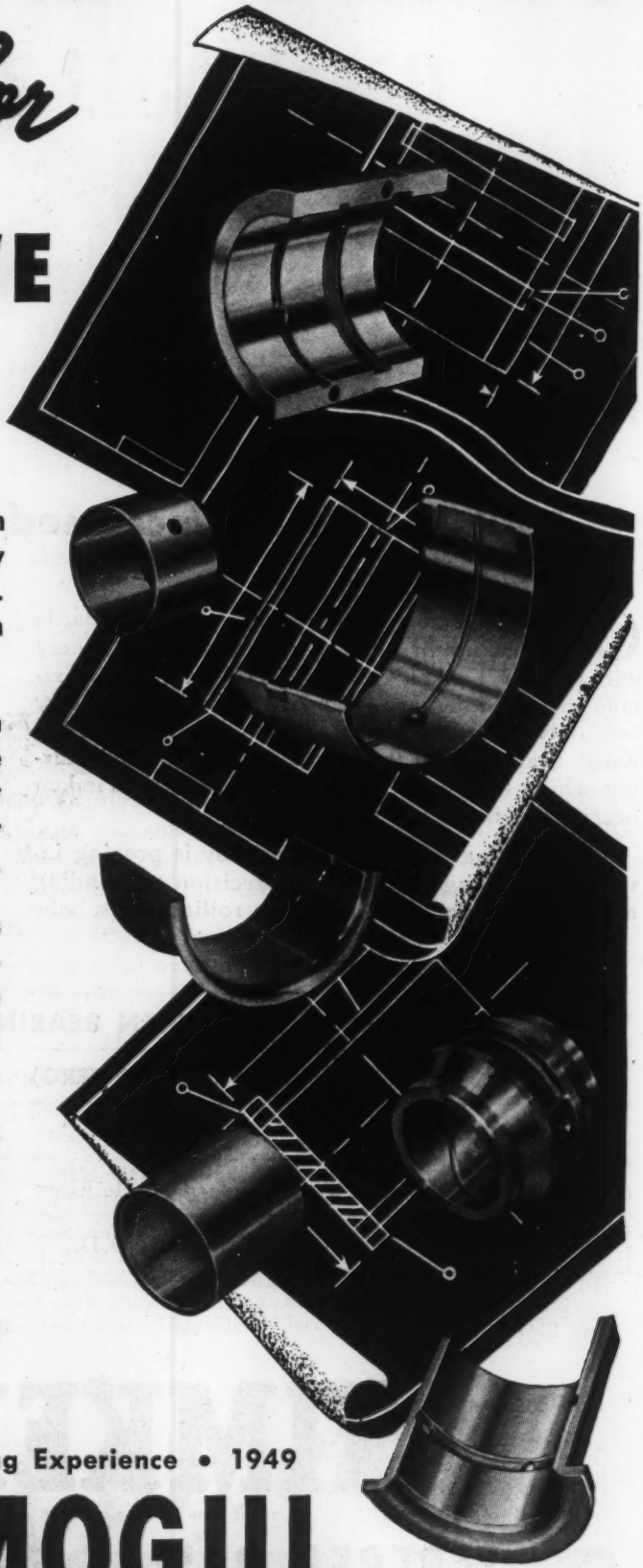
TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION →✳←

ENGINEERING DESIGN SERVICE *for* *Silent* SLEEVE BEARINGS



You can simplify your sleeve bearing design problems—without cost or obligation—by using our engineering consultation service. Fully equipped engineering and research departments are at your disposal.

We operate six manufacturing plants, each concentrating on sleeve bearing manufacture within a specific range of size and alloy combinations. Facilities are available for both large volume production and small runs.

The manufacture of sleeve bearings demands specialized knowledge, equipment and facilities. We have them. Our 50 years' experience gives us unusual advantage in this business, where *precision* is the watchword!

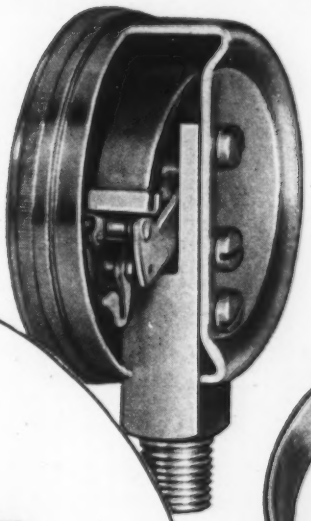
Thrust washers and precision bronze bearing parts, and large bearings (up to 27" diameter), are a specialty. Your inquiries are invited—they will get prompt attention and reply.

FEDERAL-MOGUL CORPORATION
11045 Shoemaker Avenue
Detroit 13, Michigan

1899 • Fifty Years of Continuous Bearing Experience • 1949

FEDERAL-MOGUL

Silent FEDERAL Mogul SLEEVE BEARINGS



So much protection for so little money

... and BRASS helps make it possible

In less than a decade, the production of indicating, recording and control instruments has been doubled—and then redoubled. Why? Because industry has learned that it costs so little and saves so much to *know* the pressure in an oxygen tank—the temperature in a brick kiln—or to record the cycle of a heat treating furnace.

Take, for instance, the pressure gauge illustrated: Carefully engineered, made of highest quality materials and assembled with precision workmanship—this gauge can be bought, in quantity, for less than the price of a carton of cigarettes! To make it, United States Gauge uses ten Anaconda Alloys. Each is of the composition, form, temper and finish most suitable for the purpose. Each contributes its share to a longer service life because of its durability, and its resistance to wear, fatigue and corrosion.

Little wonder that so many instrument makers depend on Brass . . . with so much of it from the mills of The American Brass Company. 48121

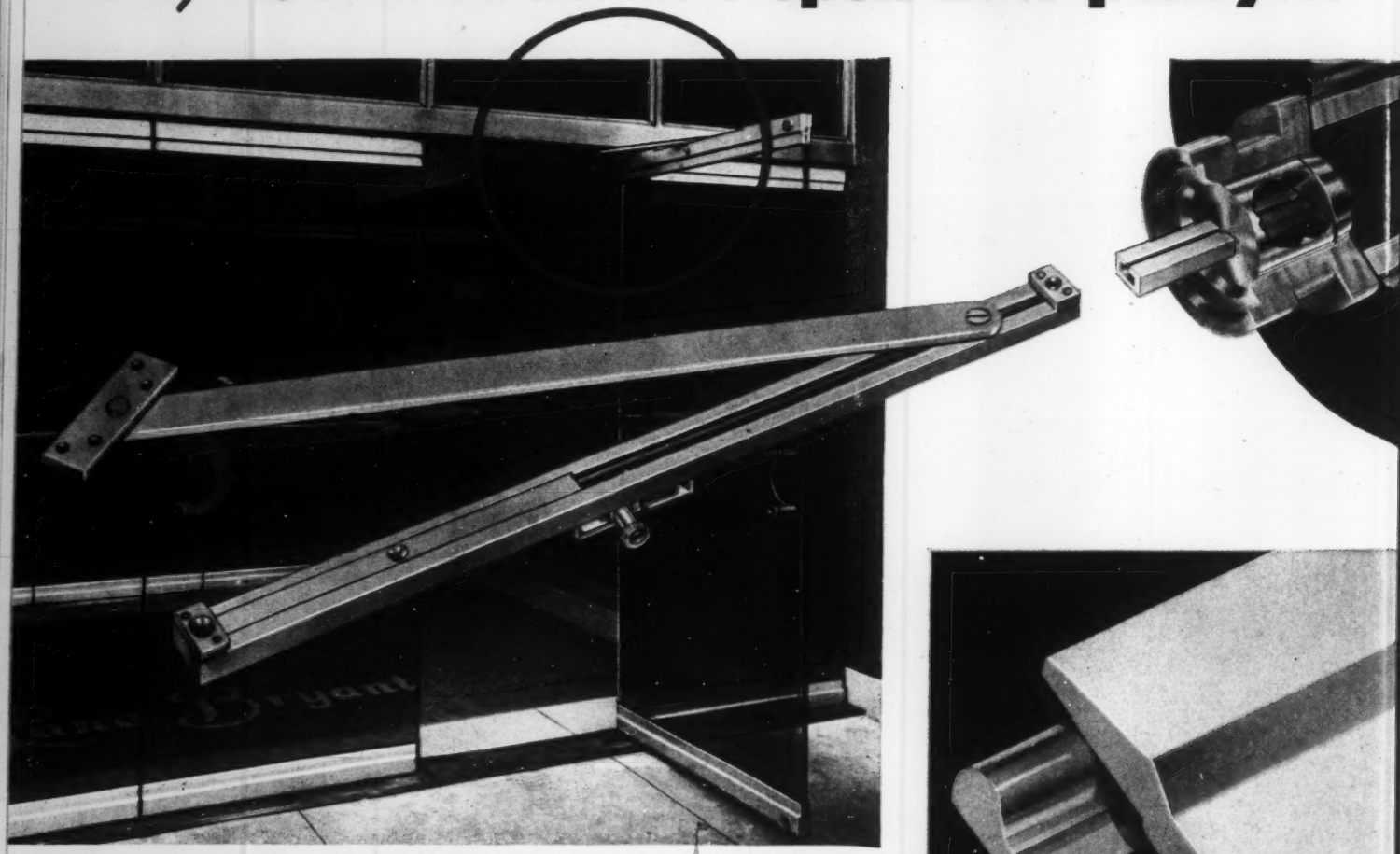
Gauge and components courtesy of
UNITED STATES GAUGE
DIVISION OF AMERICAN MACHINE AND METALS, INC.
Sellersville, Pa.

To learn how special brass shapes helped one manufacturer, see next page ▶ ▶ ▶

ANACONDA THE AMERICAN BRASS COMPANY
General Offices: Waterbury 88, Connecticut

Anaconda COPPER & COPPER ALLOYS

Every Merchant believes in the **open door policy...**

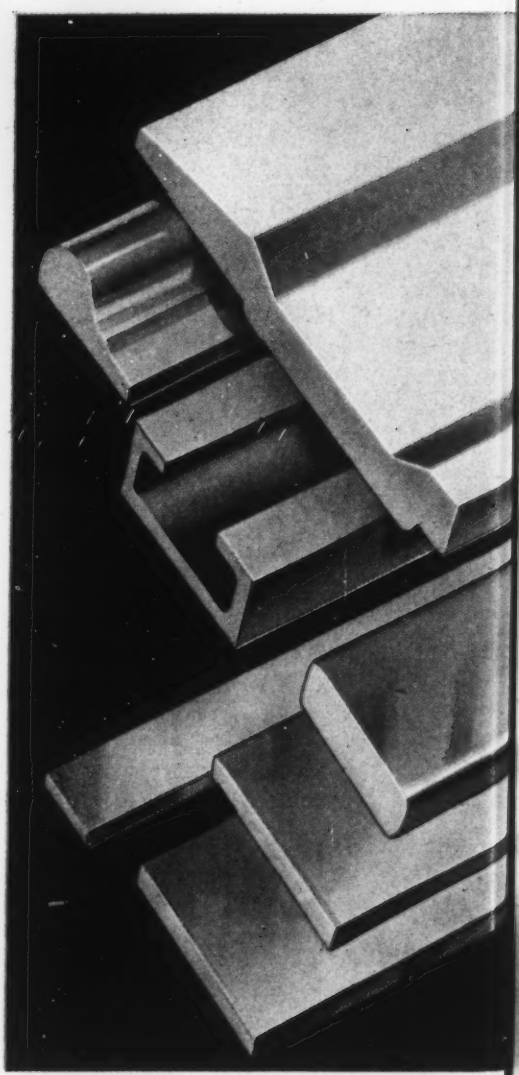


Glynn-Johnson furthers it by using EXTRUDED BRONZE SHAPES

The experience of Glynn-Johnson Corp. (Chicago) in improving its product while simplifying production should be interesting to manufacturers who must keep down costs without sacrificing quality.

These Concealed Overhead Door Holders provide a safe, smooth, "hold-open" and "shock-absorbing" control for glass doors. Glynn-Johnson reports that the use of extruded architectural bronze shapes has reduced machining time and speeded up finishing operations. Other results: Seven simplified Anaconda Extruded and Drawn Shapes are now the principal components. Bronze makes a better product, combining architectural beauty, adequate strength and maximum durability. The smooth operation that is built in, stays in.

The Anaconda Extruded and Drawn Shapes illustrated at the right are *wrought* metal... tough, strong, dense-grained, smooth-surfaced and easy to machine. Special shapes, extruded, drawn or rolled, are available in copper, brass, bronze and special copper alloys—in an almost limitless variety of cross-sections for an almost limitless number of applications. We'll be glad to tell you more about them.



Shapes used by Glynn-Johnson, slightly less than full size.

THE AMERICAN BRASS COMPANY • General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS, LTD., *New Toronto, Ont.*

ANACONDA from mine to consumer

Anaconda

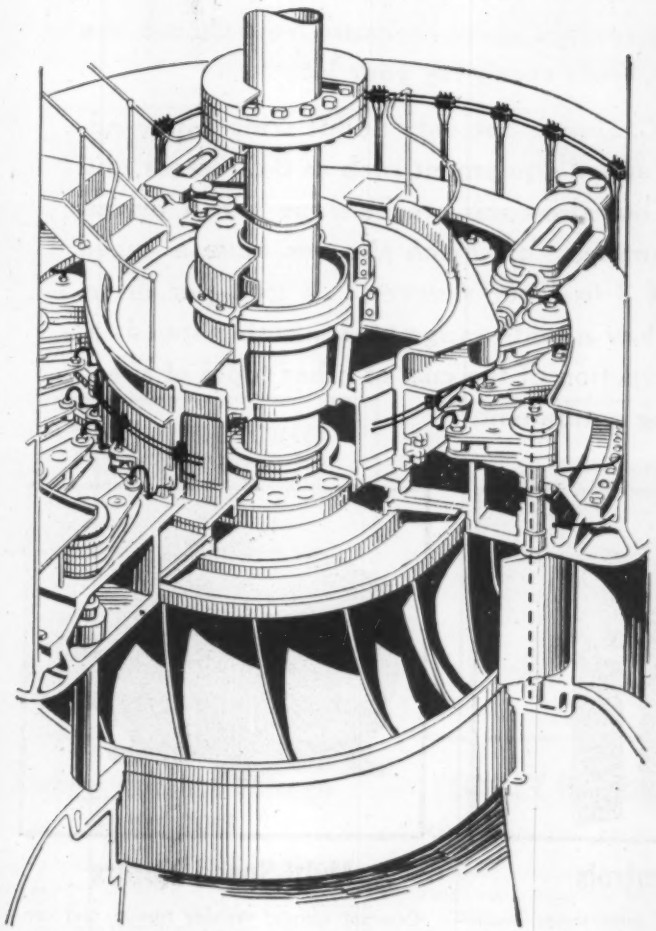
COPPER & COPPER ALLOYS

Renewed only 4 bearings in 12 years with Farval

FARVAL solves the problem of lubricating turbines in hydraulic turbo-generator plants, according to reports from station managers.

On one Farval-lubricated turbine, only four bearings were renewed in 12 years. Prior to the installation of centralized lubrication it had been necessary at this plant to replace 6 to 8 bushings every six months, each time the turbine was dewatered.

Another plant engineer says, "After 14 years we are well satisfied with Farval. When our turbines were overhauled we found very little wear on moving parts and linkages." Still another man writes, "We would never go back to the individual grease fittings of years ago. You can bet that all future turbines will be equipped with Farval."



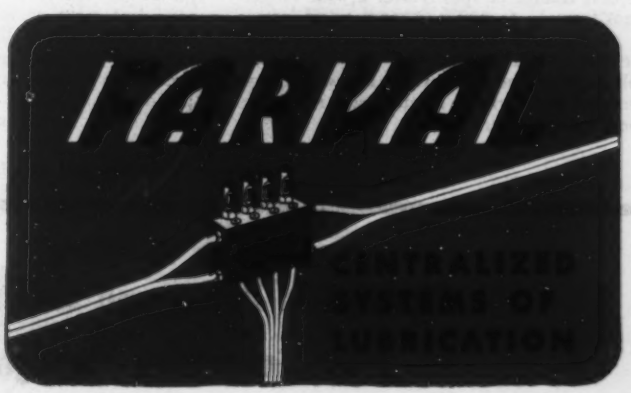
Shutting down a turbo-generator set to replace a worn or damaged bearing is expensive in labor and parts, costly in time and crippling to electric power production. Here as with so many operations throughout industry, Farval lubrication keeps equipment running efficiently, eliminating downtime and safeguarding production, not to mention the saving of labor, lubricant and new bearing costs.

Farval has proven itself in over 20 years of service. It is the original Dualine system of centralized lubrication that others imitate. The Farval valve has only 2 moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its wide valve ports and full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing —as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned. For a full description, write for Bulletin No. 25.

The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

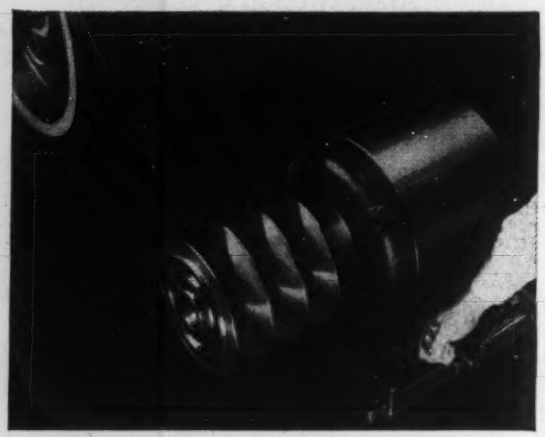
FARVAL—*Studies in Centralized Lubrication* No. 110



ALLIS-CHALMERS OFFERS EQUIPMENT

Tips on Economical

A-C ALLIS-CHALMERS

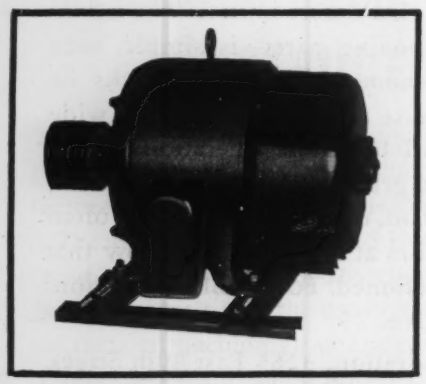


New! VARI-PITCH Automatic Sheaves

Accurate, instant speed control for most speed changing needs from 3 to 20 hp. Simply move the motor toward the driven sheave to increase machine speed . . . move it away to decrease speed. The automatic sheave does all the work. Lowest cost method of changing speeds while running.

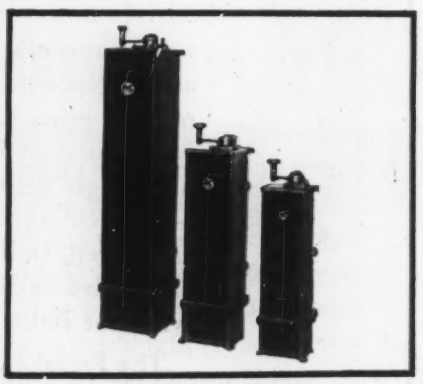
Here's a quick look at industry's widest range of adjustable speed equipment. From this line you can select a *type* of drive that will meet the exact requirements of your particular equipment . . . an *economical* drive, because you choose the *simplest, least costly* for your job!

Allis-Chalmers not only builds wide range adjustable speed equipment such as d-c motors and control, but also complete *Texrope* V-belt drives. For example, *Vari-Pitch* sheaves have a speed range of 2 to 1 per sheave . . . 4 to 1 per drive. They allow a wide range of adjustable speeds at only a fraction of the cost of other types of speed changing equipment.



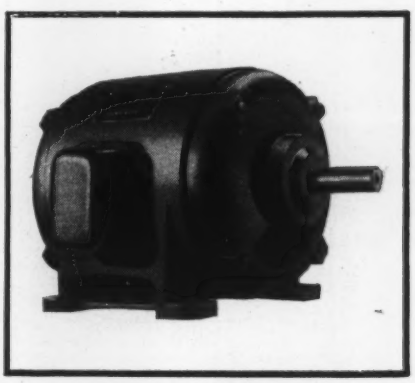
Direct Current Motors

Field resistance or armature voltage control applied to these motors give a practically stepless change of speeds over a wide range. Sizes from ½ to 200 horsepower and larger at all standard voltages. Available in such mechanical modifications as drip-proof, splash-proof and for vertical mounting. For constant and variable torque loads requiring speed adjustment.



Motor Controls

Wide range of wound rotor motor drums and resistors. Sizes from 5 to 750 horsepower in enclosed, general purpose, and semi-dust tight enclosures. For larger motors, motor operated drum controllers are available in a range of sizes. A new line of liquid slip rheostats for secondary control of wound rotor motors for use in special applications is also available.



Multi-Speed Motors

Constant torque, variable torque, and constant horsepower models in sizes from 1 to 75 horsepower. Available in either two or four speeds with overall range from 450 to 3600 rpm. Normal starting torque and current, and low starting current and high starting torque can be furnished. Combined with *Vari-Pitch* sheaves or speed changers, these motors offer wide speed range.

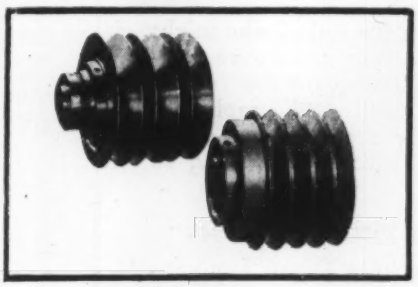
Texrope, Vari-Pitch and Reguiex are Allis-Chalmers Trademarks.

Pioneers in Power and Electrical Equipment
From Generation Through Utilization

ALLIS

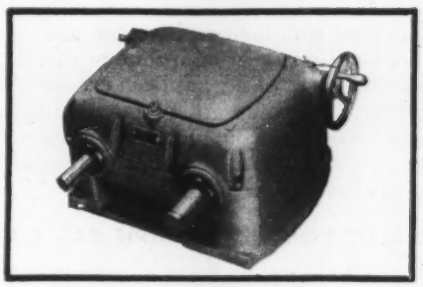
AID TO MACHINE DESIGNERS!

Adjustable Speed Drives



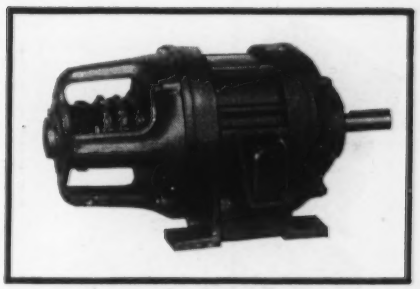
VARI-PITCH Sheaves

Standard Range *Vari-Pitch* sheaves have 15% to 25% range per sheave . . . Wide range *Vari-Pitch* sheaves 100% per sheave. Furnished in both stationary and motion control to suit application. These sheaves provide *stepless* speed changes at relatively low cost. Recommended for Textile Spinning Machines . . . Machine Tools . . . Heating and Ventilating Systems . . . others.



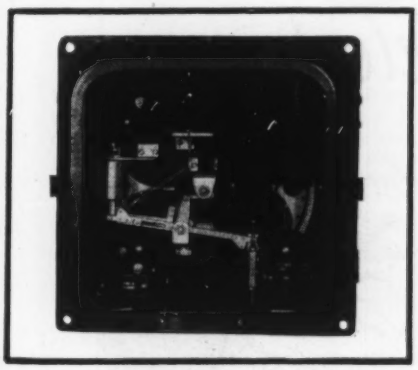
Speed Changers

Packaged speed control unit with simple handwheel for quick speed changes. Operates only in motion and provides instantly available variation of speeds through a smooth stepless range as high as 375%. Twelve sizes from 1 to 75 horsepower meet most requirements of modern machinery. This unit may also be driven through *Vari-Pitch* sheaves for even greater speed range.



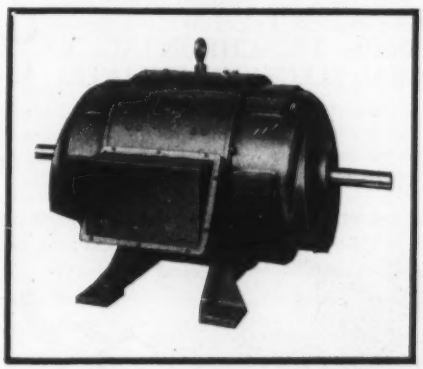
Wound Rotor Motors

For adjustable varying speed drives in sizes from 5 to 200 horsepower and larger. Wound rotor motors in conjunction with standard secondary controls offer a speed range down to 50% of synchronous speed. Starting torque characteristics of these motors make them ideal for jobs where low starting current and high starting torque are required.



Rocking Contact Voltage Regulators

Changing and holding a fixed speed on machines where the load is variable is effectively handled by Allis-Chalmers rocking contact voltage regulators. They consist of a solenoid or torque motor which rocks a hard graphite rocking contact sector against a commutator to change regulating resistance. A tachometer generator coupled to the motor shaft provides a measure of speed by supplying a voltage to the regulator coil proportional to motor speed.



REGULEX Rotating Amplifiers

Regulex amplifiers are used for speed regulation where field forcing and extremely fast response are required. *Regulex* machines provide strong corrective action because of high amplification of minute tachometer voltage changes, which has the effect of accurately and quickly controlling motor speed. These speed regulators can be used for hoists, or any drive where the load is variable and accurate speed control is needed. Can also be used for controlling almost any function of a machine which can be converted into volts, amperes or watts.

ALLIS-CHALMERS, 1001A SO. 70 ST.
MILWAUKEE, WIS.

Please send me the literature checked below:

- Handy Guide for Electric Motors — Bulletin 51B6052 ☐
- Rocking Contact Voltage Regulators
  - Bulletin 14B6035 ☐
  - Bulletin 14B6143 ☐
  - Bulletin 14B6137 ☐
- Regulex Amplifiers — Catalog Section 6030 ☐
- *Vari-Pitch* Sheaves—Bulletin 20B6082 ☐
- Speed Changers—Bulletin 20B6013 ☐
- Switchgear and Control Devices Bulletin 23B7095 ☐
- Automatic *Vari-Pitch* Sheaves Section 20P50 Part 4 ☐
- Pre-Engineered *Texrope* Drives Bulletin 20B6956 ☐

Name.....

Title.....

Firm.....

Address.....

City..... State.....

A-2724

-CHALMERS

A-C ALLIS-CHALMERS

the TRUTH about HEART TROUBLE

Why an electrocardiograph tells it

All around you, men and women are enjoying life today, who might have been cut down in the prime of life. But, thanks to the electrocardiograph, their span of life has been extended. By charting any abnormality of the heart's beat-strength or functioning, the electrocardiograph supplies the vital facts from which the physician determines whether, where or how severely the heart or heart muscles have been injured. Then he prescribes the proper treatment.

THE ELECTROCARDIOGRAPH CAN'T HAVE "HEART TROUBLE"

The heart of many of these life-savers is a Telechron Timing Motor... *instantly, constantly synchronous.* Only such an accurate, trouble-free motor can be trusted to time the chart that tells the truth about heart trouble.

WHAT IS YOUR TIMING PROBLEM?

If you have a variable that must be controlled or recorded with split-second fidelity, a standard Telechron Motor, correctly applied, may be all you need. Ask a Telechron Application Engineer. He can give you the benefit of the broadest experience in the industry. The earlier in your planning you call him, the better are your chances of saving time, trouble and money. In the meanwhile, fill in and mail the coupon below for complete data on Telechron Synchronous Motors. TELECHRON INC., A GENERAL ELECTRIC AFFILIATE.

Telechron®

Telechron Inc.
20 Union Street
Ashland, Massachusetts

Please send me information on sizes and types of Telechron Synchronous Motors. My possible application is:

- ☐ Instruments
- ☐ Timers
- ☐ Electric Appliances
- ☐ Cost Recorders
- ☐ Advertising, display items
- ☐ Juke Boxes
- ☐ Air Cond. & Heat'g Controls
- ☐ Communications Equipment

Other (please fill in)

- ☐ _____
- ☐ _____
- ☐ _____

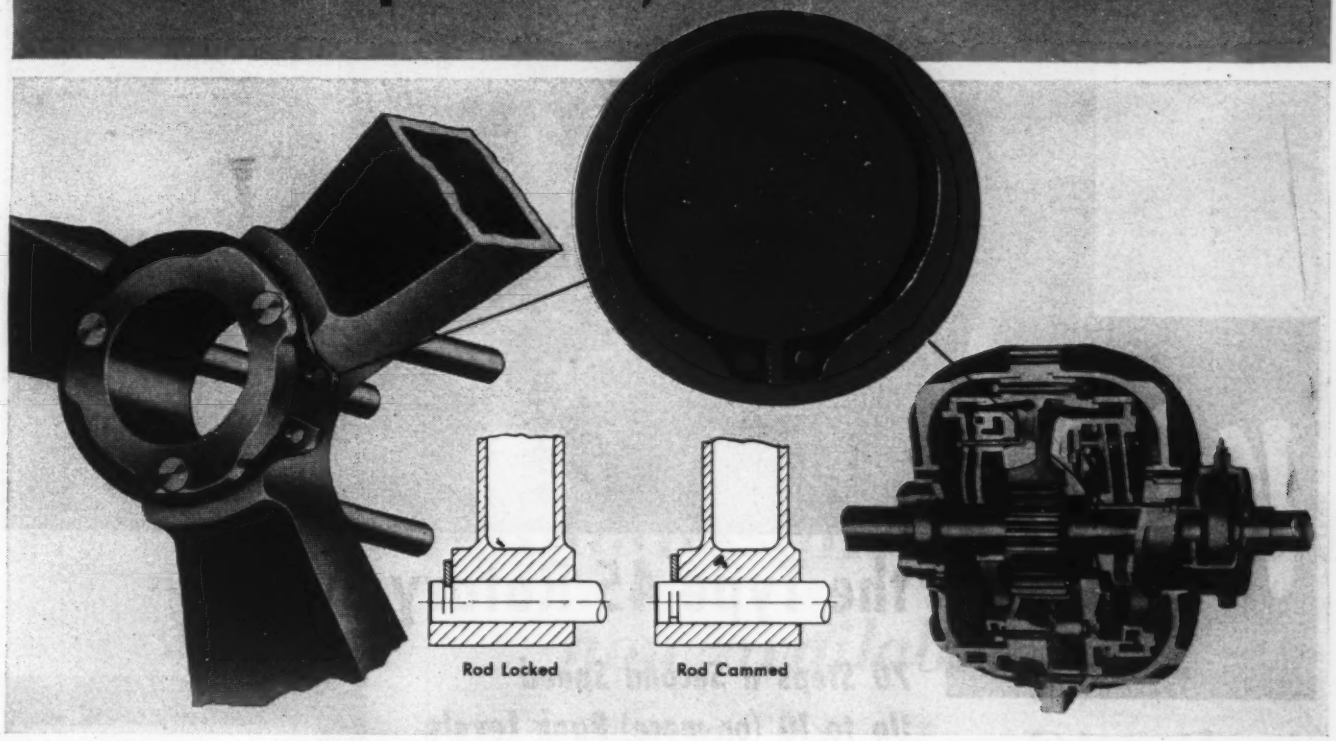
NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

Single TRUARC ring holds 3 valve rods, saves $12 production, 10 hours maintenance



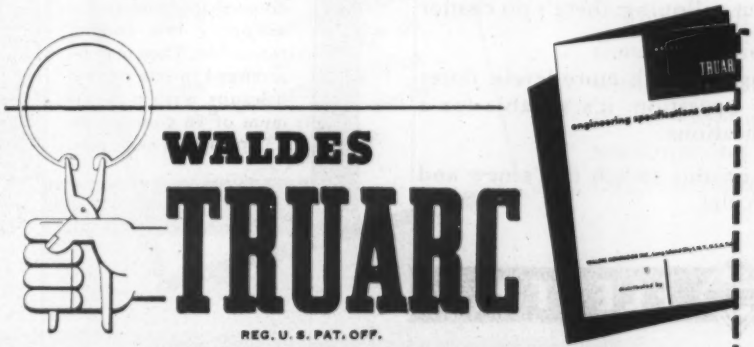
Unique feature of Thomas Varidraulic Drive design is this valve rod assembly, which permits removal and replacement of rods without disassembly of entire unit. One Truarc ring holds three rods, by engaging grooved recesses provided on one side only of each rod. When rotated 180°, rods act like cams...spread the ring...permit their easy removal. Ends of replacement rods are tapered for easy re-assembly. This design saves an average of 10 man hours of disassembly and assembly time, and eliminates the costly delay of returning the unit to the factory for repair.

Use of 8 Waldes Truarc Retaining Rings in the Varidraulic Drive results in an estimated production saving of $12.00 per unit, reports Thomas Hydraulic Speed Controls, Inc., of Wichita, Kansas.

Savings in production materials and time, plus simplification of repair procedure with Waldes Truarc Retaining Rings tell only part of the story for Thomas Hydraulic. In their own words: "Considerably less skill is required in numerous machining operations and at assembly of the drive than would have been required if the design did not use Truarc rings.

"Our use of Truarc rings has contributed substantially to a more economical design that permits sound sales pricing. Easier maintenance also provides an additional sales point."

Truarc can cut costs and improve your product, too. Wherever you use machined collars, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. Waldes Truarc Retaining Rings are precision-engineered, easy to assemble and dis-assemble. Only Truarc stays circular always, to give you a never-failing grip. Send us your drawings. Waldes Truarc engineers will be glad to show you how Truarc can help you.



WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,302,948; 2,026,454; 2,416,852 AND OTHER PATS. PEND

Waldes Kohinoor, Inc., 47-16 Austel Place MD-7
Long Island City 1, N. Y.

Please send 28-page Data Book on Waldes Truarc Retaining Rings.

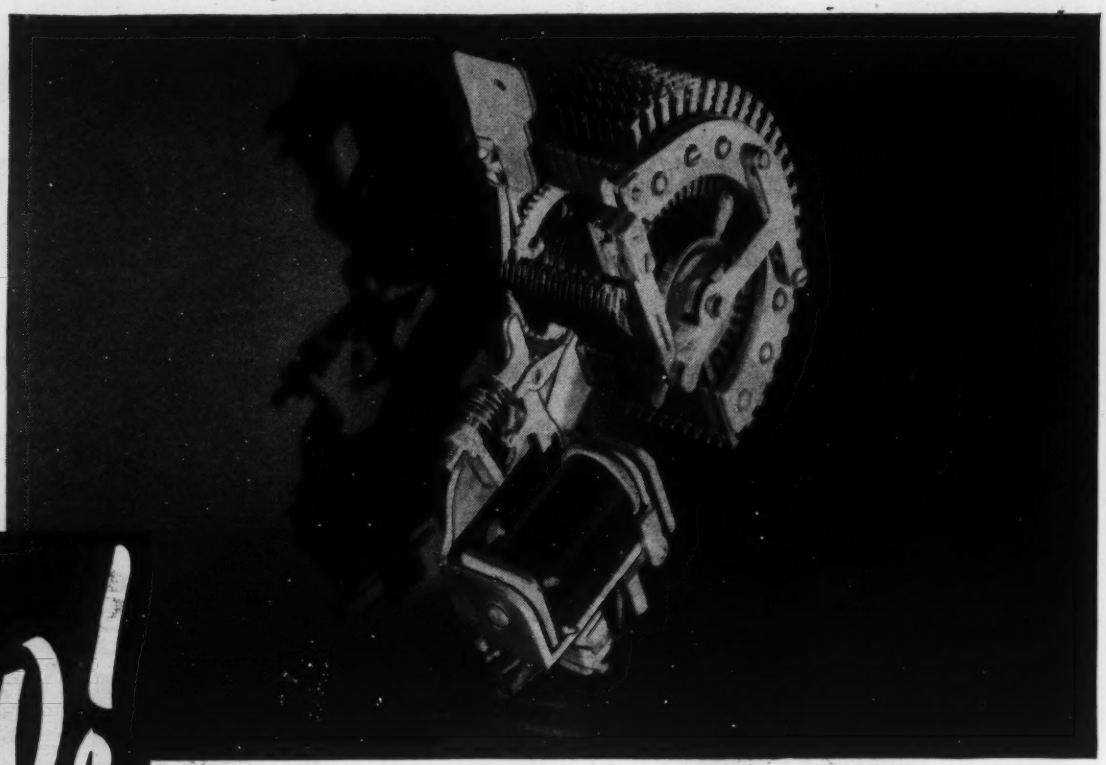
Name_____

Title_____

Company_____

Business Address_____

City_____ Zone____ State_____ ★



new!

the Type 45 Rotary Switch

70 Steps a Second Speed
Up to 10 (or more) Bank Levels
Only 1 Field Adjustment

For *all* the features you want . . . in *any* remote-control application . . . look to Automatic Electric's Type 45 Rotary Switch!

SPEED . . . it's faster! It carries 10 wipers at 70 steps a second on 46 volts d.c. self-interrupted, or at 35 steps a second, externally interrupted.

CAPACITY. . . it's greater! Ten or more 25-point bank levels can be accommodated on the same frame, and single ended wipers can be provided for 50-point operation.

ADJUSTMENT . . . it's simpler! A rare readjustment of the interrupter springs is all that's normally required.

OPERATION . . . it's smoother! With an even load on *all* contacts, the Type 45 runs without galloping; there's no chatter or bounce.

ADAPTABILITY. . . it's more useful! With more levels, faster speed and 25- or 50-point operation, it's suitable for a wider variety of control applications.

For complete information on this switch that's new and better, write for our new circular.

the Class "B" Relay

Here's a new relay, too, that can be used for ordinary relay service—opening, closing or switching circuits—and for extremely high-speed operation. Independently operating twin contacts assure perfect contact operation. Contact points are dome-shaped to maintain uniformly low contact resistance. They may be arranged in one or two pile-ups with a maximum of 16 contacts on 13 springs in each pile.

AUTOMATIC ELECTRIC

Distributors in U. S. and Possessions:
Automatic Electric Sales Corporation
1033 West Van Buren Street, Chicago 7, Illinois
In Canada: Automatic Electric (Canada) Limited, Toronto

Johansson

BROWN & SHARPE

Johansson Gage Blocks

now available through

Brown & Sharpe Distributors

NEW CATALOG

Send for a copy of the latest catalog on all Johansson Gage Blocks and Accessories . . . now made by Brown & Sharpe. This catalog contains illustrations and detailed information on the use and specifications of these world-famous standards.

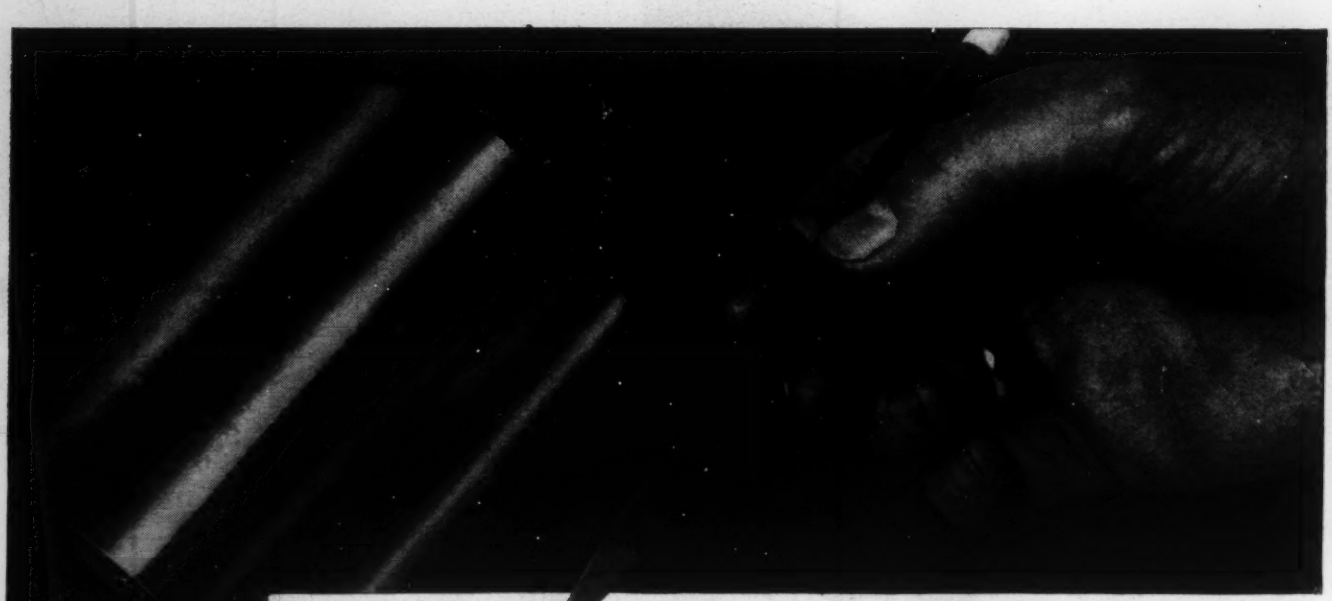
These famous precision standards of industry are conveniently accessible through Brown & Sharpe Distributors. Thus, industry is assured a continuing dependable source of supply for JO-BLOCKS and Accessories.

With the purchase of the Johansson Division from Ford Motor Company, Brown & Sharpe acquired all rights to manufacture and distribute Johansson Gage Blocks and Accessories throughout the Western Hemisphere. Since that time, it has obtained the rights to world-wide distribution.

The Brown & Sharpe name is industry's guarantee that the traditional precision of these Johansson products will be maintained without compromise. Brown & Sharpe has symbolized leadership in the development and manufacture of precision measuring devices, machines and tools for more than 100 years. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

We urge buying through the Distributor

BROWN & SHARPE



10 lbs. = 10 h.p.

THESE ROBBINS & MYERS HIGH-FREQUENCY MOTOR PARTS ARE SCARCELY LARGER THAN YOUR HAND!

Smaller Size. Lighter Weight. Better Performance. R & M High-Frequency Motor Parts can be the economical answer to *all three* of these modern problems. Here's an example—a compact drive for high-speed precision grinders.

IT PAYS TO ASK QUESTIONS . . . A *conventional* 10 h.p. motor formerly was used, with a step-up belt drive to the spindle. This arrangement was both bulky and hazardous—and maintenance and slippage were aggravated by the short centers and high speed. Why not a *built-in,* direct motor drive? *Well, why not?* It's questions like this that start progress!

NOTE THESE COMPARISONS . . . So, Robbins & Myers *powering specialists* were called in, and the motor parts you see here were developed. Where the previous motor weighed about 120 pounds, *this* rotor-stator weighs but 10. In space, the former motor occupied some 2100 cubic inches; the new elements *only* 54. Use of high-frequency current provides the necessary spindle speed. And the drive is safe—*entirely enclosed*—with no slippage to jeopardize accuracy.

YOU, TOO, CAN PROFIT . . . If *you* are designing or redesigning to make your products better, *easier to sell,* call in Robbins & Myers. Fifty years of powering progress is yours for the asking. Address *Robbins & Myers, Inc., Motor Division, Dept. E-79, Springfield 99, Ohio.*

● Robbins & Myers also builds fractional and integral motors of all types in sizes to 30 h.p.; motor-generator sets to 5000 watts; and induction-type "Uni-Verters" to 15 KW for converting 60-cycle current into higher frequencies. Millions of things in everyday use are dependably powered by Robbins & Myers.

BUILD IT LIGHTER, SMALLER, BETTER-LOOKING, WITH

R & M MATCHED MOTOR PARTS

Aircraft Quality FORGINGS

These aircraft jet engine shafts are an example of the quality of forgings and finished machining produced at National Forge.

The steel itself must be made to standards which can only be established by experience and maintained by exceptional ability. National Forge's own electric furnace steel is used, carefully handled to avoid the development of any detrimental condition. Forging, annealing, rough-turning, boring, and heat treating are carried out by people skilled in each process to insure the required quality and ability of the forging to withstand high rotative stresses and temperatures. Frequent checks, such as macro etch discs and magnaflux examination are made to insure this quality through more than eighty operations required to make these shafts.

Finished machining is done to extremely close tolerances. Flanges, splines, threads and bearing surfaces require a variety of special tools and skill on the part of the craftsmen who operate them.

It is unique to find facilities of this kind under one roof. At National Forge there is complete control from the making of the original steel to the final high finish.

National Forge's complete facilities are at **your** disposal. May we have your inquiry on your next forging requirement?

NF

National Forge

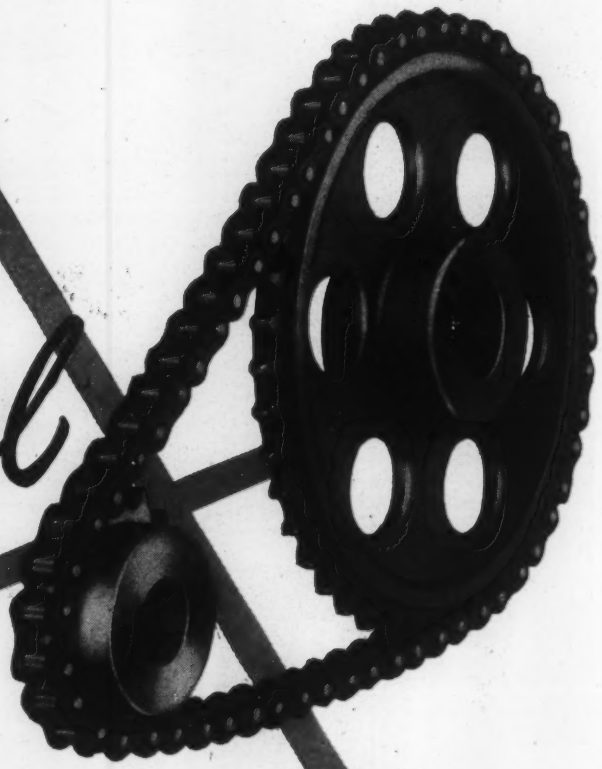
AND ORDNANCE COMPANY

Irvine, Warren County, Pennsylvania

STEEL MAKERS ☆ FORGESMITHS
HEAT TREATERS ☆ MACHINISTS

standard

yet special



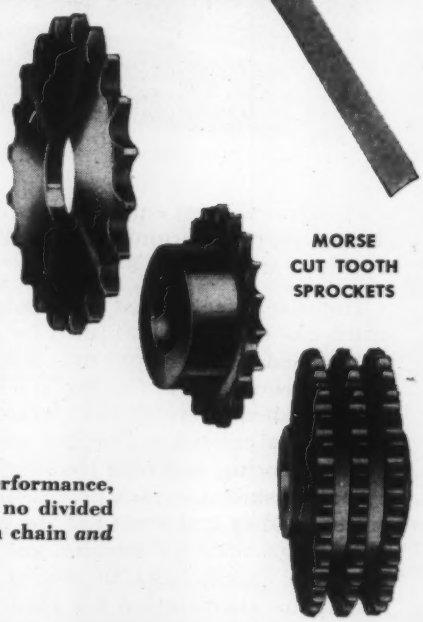
MORSE ROLLER CHAIN DRIVES

MORSE ROLLER CHAIN, made in American manufacturers' standard sizes, to standard dimensions as approved by the A.S.M.E and A.G.M.A., is *more* than standard in performance.

Its extra ruggedness, high efficiency, and dependable service have stamped it in the minds of designers and engineers as extra special for better mechanical power transmission.

Available in single and multiple widths, with pitches from 3/8" to 2½", Morse Roller Chain represents the result of engineering skill applied to a practical knowledge of chain design.

You get low-cost, positive, efficient, flexible chain drives for your mechanical power transmission with Morse Roller Chain. For complete information, write Dept. 389, Morse Chain Company, Detroit 8, Mich.



MORSE CUT TOOTH SPROCKETS

Morse Cut Tooth Sprockets, accurately machined for top performance, are recommended for use with Morse Roller Chain. There's no divided responsibility for chain drive performance when you get both chain *and* sprockets from Morse.

Morse Morflex Coupling

MORSE

MECHANICAL *POWER TRANSMISSION* PRODUCTS

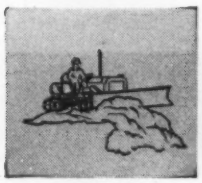
A PRODUCT OF B-W BORG-WARNER

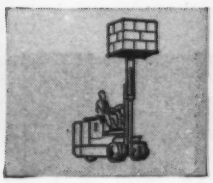
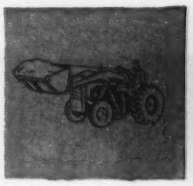
Morse Silent Chain Drives

Morse-Rockford Clutches

Morse-Rockford Pullmore Clutches

MORSE CHAIN COMPANY DETROIT 8, MICHIGAN

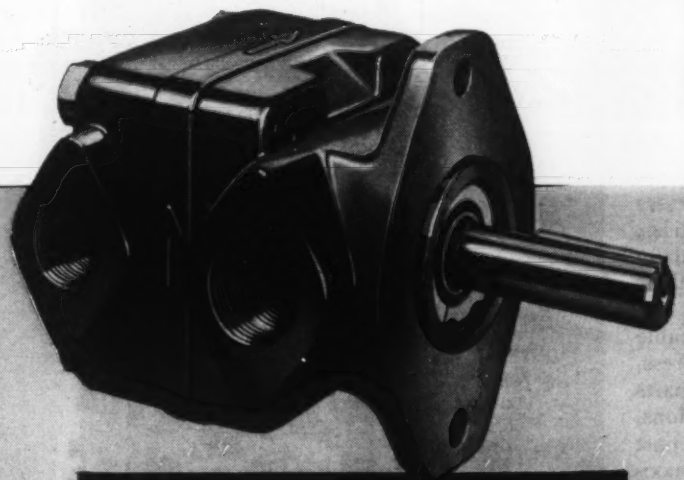


the pump designed SPECIFICALLY FOR mobile equipment service

the NEW series V-200

VICKERS
BALANCED VANE PUMP



THE ONLY PUMP THAT AUTOMATICALLY MAINTAINS CORRECT RADIAL AND LATERAL CLEARANCES AT ALL TIMES

The rigorous job requirements of construction, agricultural, automotive and materials handling machinery have long pointed out the need for a hydraulic pump expressly designed for this service. The new Vickers V-200 Balanced Vane Pump has been designed and developed to meet these requirements with the usual Vickers high quality workmanship . . . all adding up to the "Best Pump Value" for this industry.

Longer life at maximum efficiency, far in excess of fixed clearance pumps, is assured as the Vickers Pump is the only pump designed to maintain both radial and lateral running clearances at all times. Not only is normal wear perfectly compensated, the pump even automatically adjusts its clearances to oil viscosity variations resulting from temperature change. As a result, correct clearances are maintained and more oil is delivered for useful work.

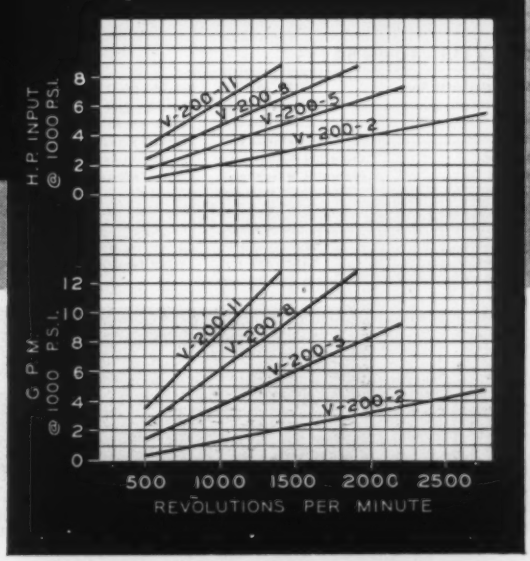
For many installations the nominal rated capacity of the pump is adequate, making it unnecessary to select the next larger size to provide additional capacity to compensate for loss due to high operating pressures, increased temperatures or normal wear. Thus, in many cases, a smaller pump can be used resulting in a more compact, efficient, and economical installation.

The tried and proven Vickers feature of "hydraulic balance" eliminates bearing loads resulting from pressure. The vane principle provides for no-load starting . . . important in cold weather cranking. Greater mounting adaptability is another advantage.

For better service, much longer life, with maximum efficiency all the way . . . you need Vickers V-200 Pump on your mobile equipment. Write for Bulletin 49-52.

AVAILABLE IN FOUR CAPACITIES WITH THE SAME EXTERIOR DIMENSIONS

TYPICAL PERFORMANCE CURVES



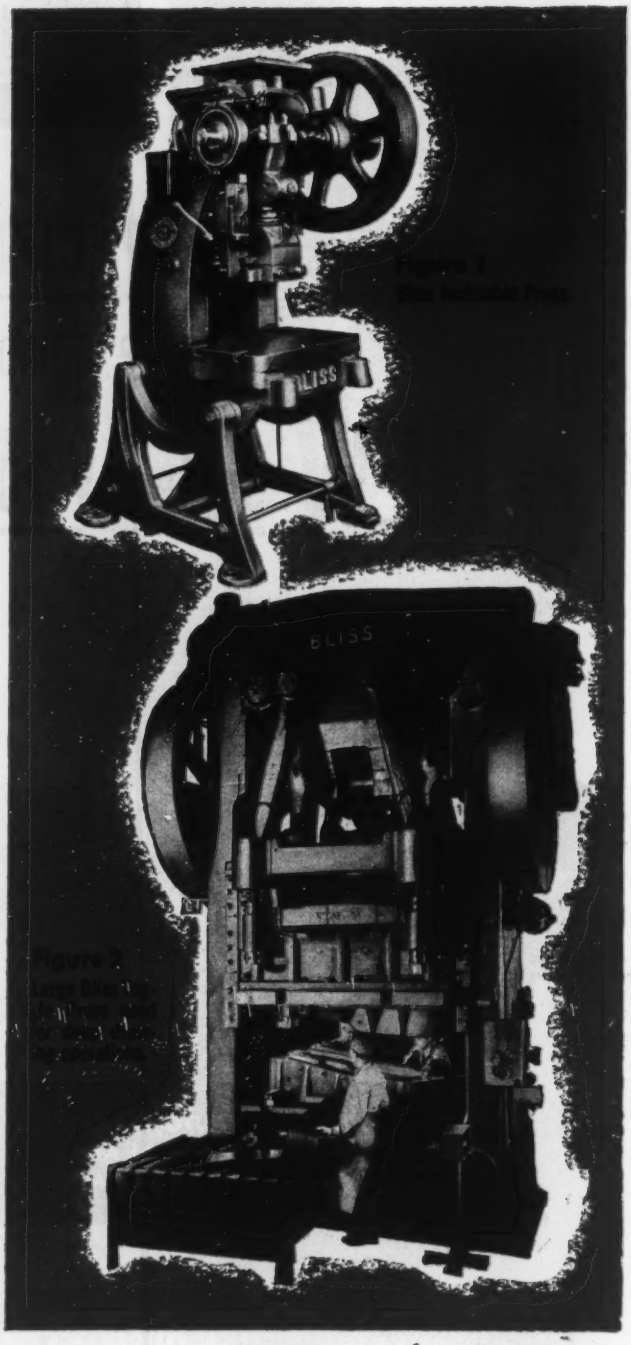
Write for **NEW BULLETIN 49-52**

3903

VICKERS
Incorporated
DIVISION OF THE SPERRY CORPORATION
1430 OAKMAN BLVD. • DETROIT 32, MICHIGAN

Application Engineering Offices: ATLANTA • CHICAGO CINCINNATI • CLEVELAND • DETROIT • LOS ANGELES • NEWARK PHILADELPHIA • PITTSBURGH • ROCHESTER • ROCKFORD ST. LOUIS • SEATTLE • TULSA • WASHINGTON • WORCESTER

ALL IRON CASTINGS ON BLISS PRESSES ARE MEEHANITE® METAL



E. W. BLISS COMPANY, Detroit, Michigan, prominent manufacturers of a line of mechanical and hydraulic presses as well as other machinery, operate two Meehanite foundries. The hundreds of tons of Meehanite castings produced in these plants are used as structural components for their products.

In their line of presses ranging from a small Inclinable Press, Figure 1, to the Giant deep-drawing Toggle Press, Figure 2, Meehanite castings are used for such important parts as frames, flywheels, brake and clutch housings, connections, slides, etc. Presses of these types must be rugged and must perform precision work. Their design must incorporate maximum rigidity for die life with a proper safety factor below the elastic limit of the structural material in order to be sure of eliminating permanent set. Meehanite castings provide these qualities accompanied by resistance to fatigue and impact, high compressive and tensile strength and excellent vibration absorption qualities.

For further facts about the importance of quality castings as units of construction write for the bulletin "The Vital Component—Good Castings." For a copy write to any of the foundries listed.

MEEHANITE FOUNDRIES

American Brake Shoe Co. — Mahwah, New Jersey
The American Laundry Machinery Co. — Rochester, New York
Atlas Foundry Co. — Detroit, Michigan
Banner Iron Works — St. Louis, Missouri
Barnett Foundry & Machine Co. — Irvington, New Jersey
H. W. Butterworth & Sons Co. — Bethayres, Pennsylvania
Continental Gin Co. — Birmingham, Alabama
The Cooper-Bessemer Corp. — Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co. — Portland, Oregon
Farrel-Birmingham Co., Inc. — Ansonia, Connecticut
Florence Pipe Foundry & Machine Co. — Florence, New Jersey
Fulton Foundry & Machine Co., Inc. — Cleveland, Ohio
General Foundry & Manufacturing Co. — Flint, Michigan
Greenlee Foundry Co. — Chicago, Illinois
The Hamilton Foundry & Machine Co. — Hamilton, Ohio
The Henry Perkins Co. — Bridgewater, Massachusetts
Johnstone Foundries, Inc. — Grove City, Pennsylvania
Kanawha Manufacturing Co. — Charleston, West Virginia
Koehring Co. — Milwaukee, Wisconsin
Lincoln Foundry Corp. — Los Angeles, California
E. Long Ltd. — Orillia, Ontario
Otis-Fensom Elevator Co., Ltd. — Hamilton, Ontario
Pohlman Foundry Co., Inc. — Buffalo, New York
Rosedale Foundry & Machine Co. — Pittsburgh, Pennsylvania
Ross-Meehan Foundries — Chattanooga, Tennessee
Shenango-Penn Mold Co. — Dover, Ohio
Smith Industries, Inc. — Indianapolis, Ind.
Standard Foundry Co. — Worcester, Massachusetts
The Stearns-Roger Manufacturing Co. — Denver, Colorado
Traylor Engineering & Mfg. Co. — Allentown, Pennsylvania
U. S. Challenge Co. — Centerville, Iowa
Valley Iron Works, Inc. — St. Paul, Minnesota
Vulcan Foundry Co. — Oakland, California
Warren Foundry & Pipe Corporation — Phillipsburg, New Jersey

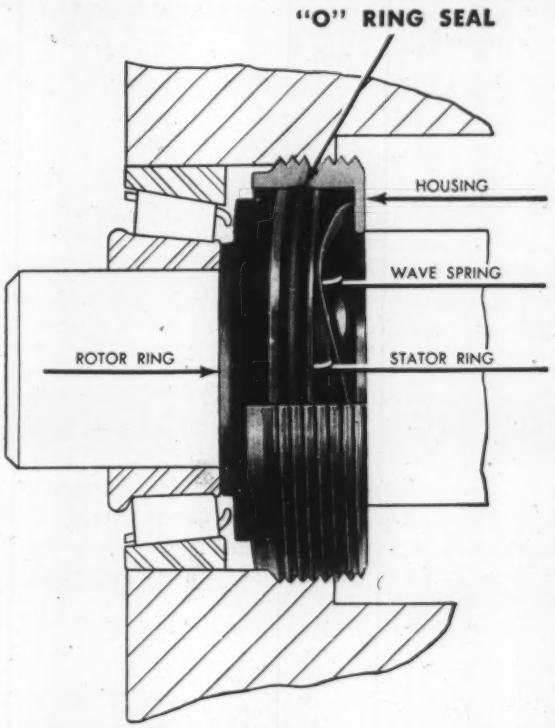
"This advertisement sponsored by foundries listed above."

Meehanite® NEW ROCHELLE, N. Y.

USE "O" RING SEALS

(The modern packing method)

for SIMPLICITY · RELIABILITY · LOW COST · SPACE SAVINGS

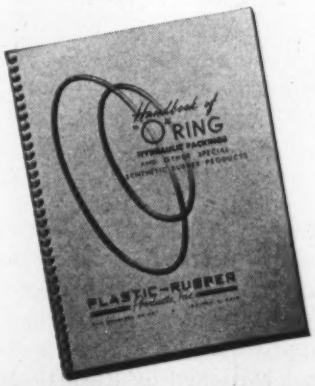


This face type, hydraulically balanced, positive seal made by CARTRISEAL CORPORATION of Chicago, Illinois, uses an "O" Ring to seal between the sliding member and the housing.

These compact sealing units are being used on steam turbines, gear boxes, pumps, hydraulic couplings, washing machines, meat grinders, and a host of other applications where long life, no leakage and trouble-free performance are required.

The "O" Rings are made from selected synthetic rubber compounds for leakproof service with gases, water, oils and special fluids—temperatures to 250° F—pressures to 1000 P.S.I.

PRP engineers will welcome an opportunity to discuss the possible application of "O" Rings to your products now in design or in production.



● Investigate "O" Ring Seals. Consult the "O" Ring specialists. Send for our "O" Ring Handbook. It's free.

PLASTIC and RUBBER
Products, Inc.

Box 431, Dayton 1, Ohio

Topics

VARIABLE-SPEED a-c motor, delivering variable torques, is being developed by the Charles E. Ellis Co., New York. Control of the speed-torque relationship is effected by mechanically setting the skew of the stator slots with respect to the rotor axis. Axial paths of the flux may be skewed either right or left hand to form a helical path of variable pitch, the pitch determining the speed and direction of the motor.

LUBRICATING OIL can be satisfactorily defoamed by recycling it through a column of activated charcoal, according to a report prepared for the National Advisory Committee for Aeronautics and now available as Technical Note 1845 from the Committee at Washington 25, D. C.

INCREASED HORSEPOWER rating for Cog-Belts has been announced by the Dayton Rubber Co. Forty per cent more power may be transmitted than formerly due to the construction of the belt, allowing more compact installations where space is limited or at a premium.

MAGNESIUM die castings as large as three pounds have been produced in Germany by a novel fully automatic machine. By using the principles of this Mahle machine, observers feel that a more uniformly high quality output might be achieved than is now possible. High hydraulic pressure is used for all operating and locking pressures of the press as well as for the cores and for ejection of the casting.

CONSTRUCTIVE ANALYSIS on the methods and results of teaching of process metallurgy in colleges is being undertaken by a committee of ASM. The committee will explore the opportunities for bringing teaching into step with modern advances in science and for orderly classification of processes.

GAS TURBINE, unchallenged for propelling high-speed aircraft, appears unlikely to become a satisfactory cheap power plant for automobiles in the near future, according to W. A. Turunen of General Motors. Limitations include high fuel consumption and objectionable exhaust, as well as need for large reduction gear ratios, foolproof safety controls, and separate device for braking torque.

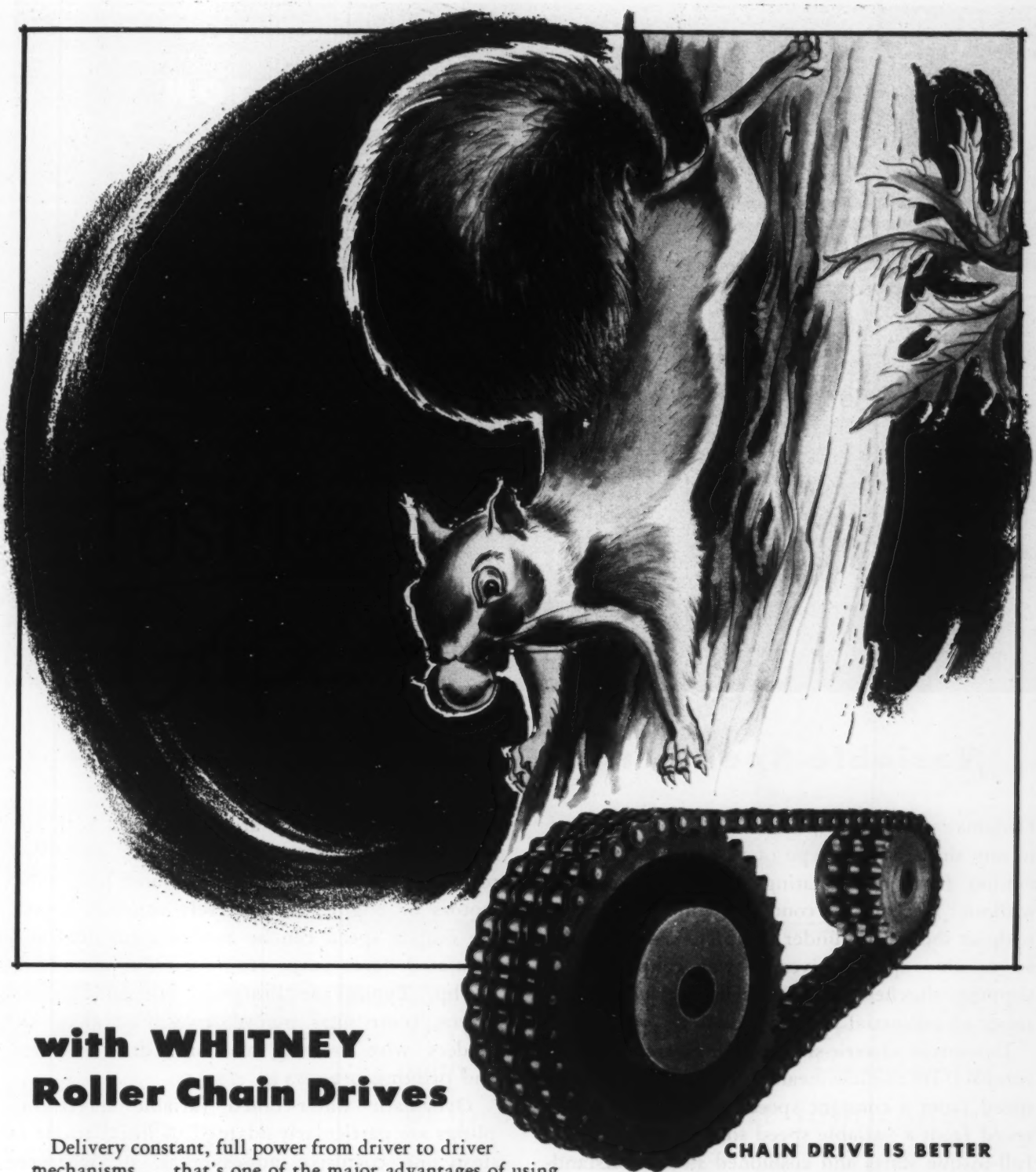
SUBMINIATURE decade ring counters, designed by Sylvania Electric Products Inc. for electronic computers, measure only 2 by 2½ inches overall. Each unit includes 11 subminiature thyratron tubes, 80 resistors and 23 capacitors. Counter is subdivided into 11 sections, each attached to a ceramic card on which the wiring is printed to connect the circuit elements.

PULVERIZED COAL is made to flow like water through a pipe by agitating it to a "boil" with an air current. Developed by the Bureau of Mines for producing synthesis gas required for manufacturing synthetic liquid fuels, the method feeds at a constant instantaneous rate unattainable with mechanical feeders.

OVER FOUR BILLION spot and projection welds were made by automobile manufacturers in one month while producing the bodies for 500,000 cars. In addition, according to the Ford Motor Co., a typical automobile frame contains another 170 resistance welds plus hundreds of welds in other parts.

CONVEYOR BELT with corrugated surface will raise light goods in cartons or heavy materials in bags up inclines of 30 to 40 degrees. Top surface of neoprene-natural rubber has a corrugated design approximately 3/32-inch deep on 5/16-inch centers. Designed by Russell Mfg. Co. the belt is self cleaning when it flexes around the pulleys.

INVENTIVENESS and ingenuity are stimulated among engineering students at Purdue through awards established by W. L. Batt, president of SKF. The awards given this year were for a novel electric tachometer, a moisture-resistant building block, an electric adding machine, and a device for recording rate of gasoline consumption for vehicles.



with WHITNEY Roller Chain Drives

Delivery constant, full power from driver to driver mechanisms . . . that's one of the major advantages of using chain drives.

Deeply seated in the sprocket, Whitney Roller Chain eliminates power loss because there is no slippage or friction loss. This means that full rated horsepower is delivered . . . constant speed maintained . . . highest transmission efficiency always obtained.

In addition, Whitney Chain absorbs shock loads without breakage, assuring long operating life; while the flexibility and adaptability of chain drives simplifies design problems.

For positive power transmission specify and use Whitney Roller Chain . . . the *all steel drive*. Write for information.

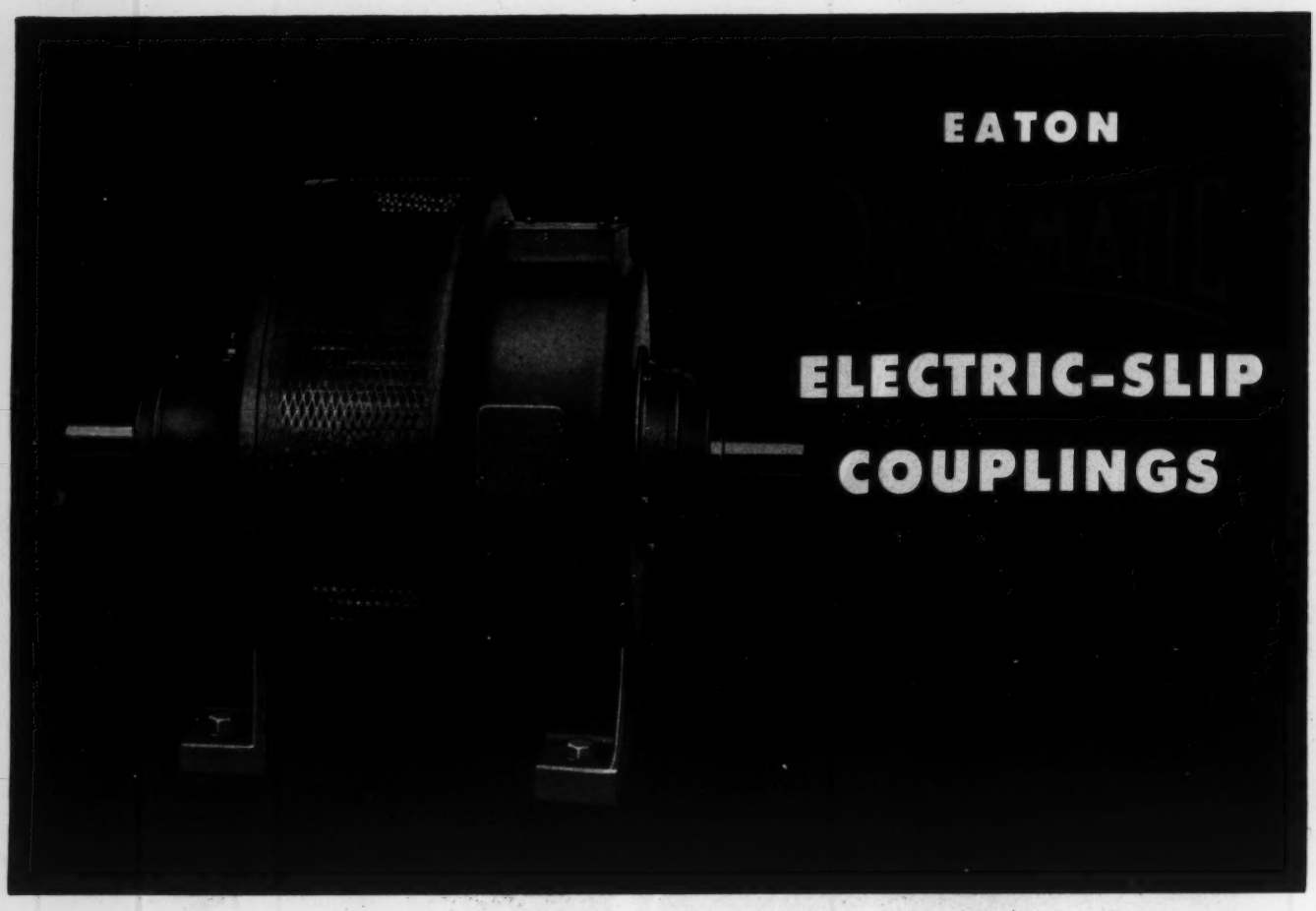
CHAIN DRIVE IS BETTER

- Positive Grip
- Transmission of full horsepower
- High resistance to shock loads
- High load carrying capacity
- Simplifying transmission designs
- Low Maintenance
- Ease of installation
- Long operating life
- Constant uniform speeds

WHITNEY

ROLLER CHAIN DRIVES

WHITNEY CHAIN & MFG. CO.
Division of
Whitney-Hanson Industries Inc.
205 Hamilton St.,
Hartford 2, Conn.



Variable Speed from Constant Speed Source

Dynamatic Electric-Slip Couplings can be applied to any shaft, in any type of machine to transmit motion from one rotating member to another without mechanical contact, without friction, without shock, and under complete control. Used as variable speed drives, power couplings, or slipping clutches, Dynamatic units have a wide range of industrial applications.

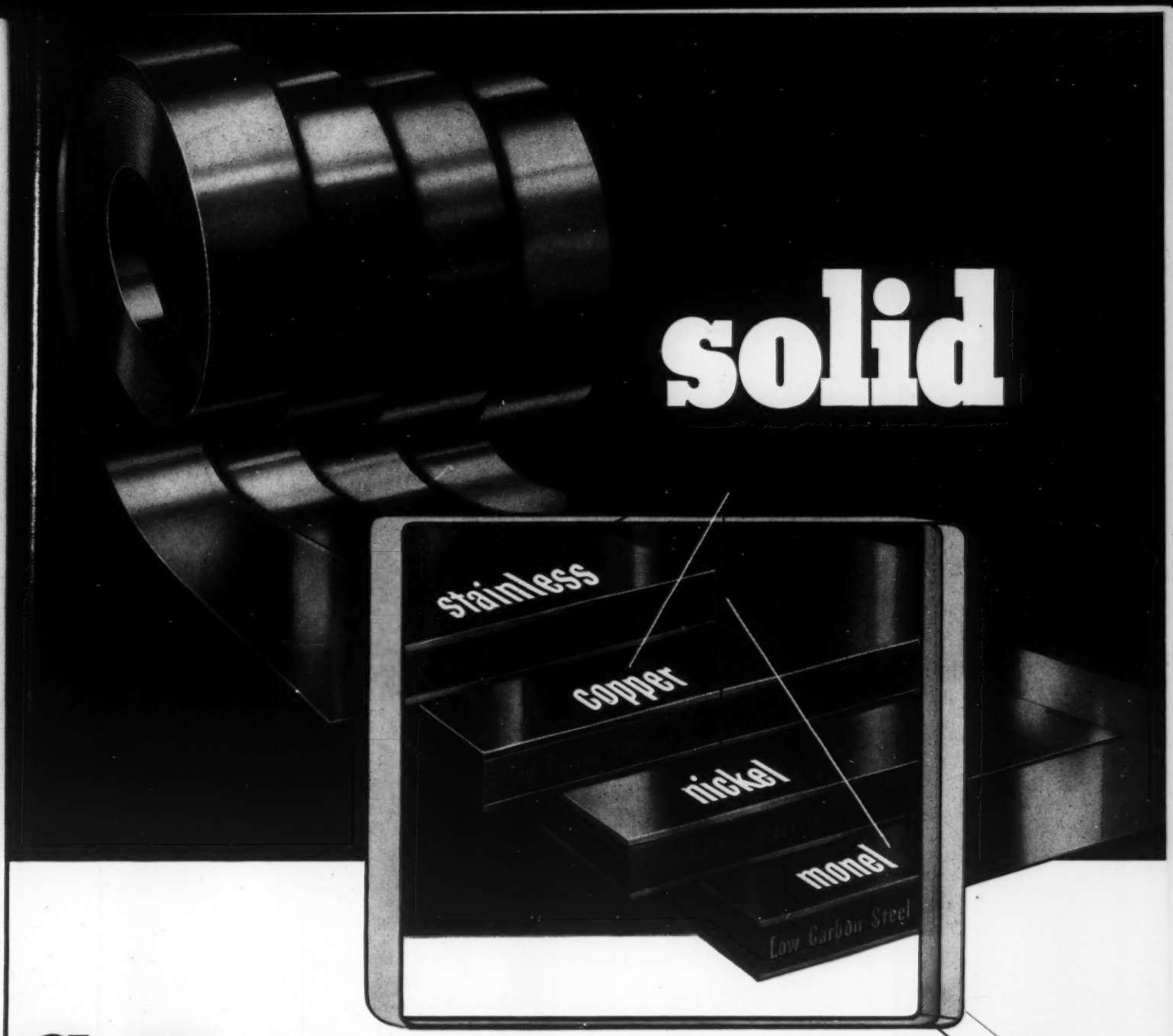
Dynamatic electric-slip couplings are a simple, compact, frictionless means of providing variable speed from a constant speed source, or constant speed from a variable speed source, with smooth, full-torque starts and cushioned stops. Outstanding characteristics are infinitely variable control, instantaneous response, quiet operation, low maintenance, electronic control.

Dynamatic couplings are available in both air-cooled and water-cooled types. The air-cooled couplings are designed to be powered by electric motors or engines at relatively constant speed; the output speed can be readily controlled and regulated. Sizes range from 1/4 hp to thousands of hp. Typical applications: fan and blower drives, centrifugal pump drives, calenders, extruders, wire drawing machines, draw benches, and printing presses.

Dynamatic water-cooled variable speed couplings are particularly adapted to installations in dusty or corrosive atmospheres, or wherever explosion-proof protection is necessary. Silent operation is a desirable feature. Sizes range from 10 hp to 1500 hp. Write for illustrated literature.

EATON MANUFACTURING COMPANY • CLEVELAND, OHIO
ADDRESS INQUIRIES TO: DYNAMATIC DIVISION • KENOSHA, WISCONSIN

PRODUCTS: SODIUM COOLED, POPPET, AND FREE VALVES • TAPPETS • HYDRAULIC VALVE LIFTERS • VALVE SEAT INSERTS • ROTOR PUMPS • MOTOR TRUCK AXLES • PERMANENT MOLD GRAY IRON CASTINGS • HEATER-DEFROSTER UNITS • SNAP RINGS • SPRINGTITES SPRING WASHERS • COLD DRAWN STEEL • STAMPINGS • LEAF AND COIL SPRINGS • DYNAMATIC DRIVES, BRAKES, DYNAMOMETERS



SuVeneer®

CLAD METALS

Give you high-performance surfaces with economy inside . . . for a world of profitable product fabrication!

You get the *solid* metal surface of your choice when you specify SuVENEER CLAD METAL . . . dense, non-porous, non-peeling, impermeable . . . bonded inseparably to a core of low carbon strip steel. You enjoy economy of purchase, while assuring performance values for your products inherent in the cladding metal you select. • Quality-produced SuVeneer Clad Metals are available in easy-handling coils, precise in every specification. *Write us on your requirements.*

Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA

AUTO-LITE

DIE CASTINGS

● Increased production facilities for die castings made possible through the famous Auto-Lite "controlled metals" processes are now available. The opening of the great new Lockland plant of Auto-Lite, combined with the enlarged facilities at Woodstock, Illinois, greatly increases Auto-Lite's ability to furnish high quality die castings.

AUTO-LITE MEANS PRECISION MANUFACTURING

THE ELECTRIC AUTO-LITE COMPANY
Die Casting Division, Woodstock, Illinois

600 S. Michigan Ave.
Chicago 5, Illinois

723 New Center Bldg.
Detroit 2, Michigan

Inquiries invited

Catalog will be sent on request.
Write on your company letterhead.

JUNE, 1949

MACHINE DESIGN
A PENTON PUBLICATION

Reducing Assembly Costs

IN CHANGING ITS NAME to the Industrial Fasteners Institute, the former American Institute of Bolt, Nut and Rivet Manufacturers has not only relieved itself of a cumbersome name but has focused attention on the constantly widening variety of machine components now included in the category of fasteners. It is indeed a far cry from the days when bolts, nuts and rivets comprised the whole scope of the fasteners field.

Development of improved fasteners has been forced by the need for quick and inexpensive assembly of mass-produced parts. Without these new fasteners the full benefits of mass production of parts would have been lost in inefficient assembly practices. An equally important requirement—effective locking—has brought forth numerous successful designs to eliminate tedious jam-nut and similar assembly techniques.

Even in the field of conventional bolts and screws, significant steps toward simplification and cost reduction are being taken. The new 2A and 2B thread classifications, discussed elsewhere in this issue, will soon be used for virtually all fasteners employing threads, giving promise of savings due to reduction in number of tools and gages required. It is significant to note that the 2A classification, which will be standard for all commonly used bolts and screws, has been provided with enough clearance for quick assembly by high-speed wrenching methods, thus contributing toward lower assembly costs.

The ingenuity of engineers in developing new fasteners, and new machines to make fasteners more economically, has made available to machine designers a wide choice of characteristics. There is little doubt that many designs on the boards today could be improved substantially by proper fastener selection and appropriate redesign for ease of assembly. With increasing competition and continuing high production costs, improved assembly methods offer a relatively unexplored field for significant cost savings.

Colin Carmichael

EDITOR

Pretzel tying machine

duplicates motions of hands and fingers

By Russell G. Zuefle

Product Engineer
American Machine & Foundry Co.
Buffalo, N. Y.

FOR MANY centuries, the salty little biscuit known as a pretzel has been fashioned by hand in substantially the same form that we see it today. So persistent has been the public demand for the traditional shape with a twist in the center and a loop on each side, that many attempts have been made to simplify the arduous work of tying the billions of knots now required annually. Although both die-stamped and extruded pretzels are being marketed, the manual process is actually duplicated in the American Machine and Foundry Co. pretzel tying machine. Metal fingers replace those of the crafts-

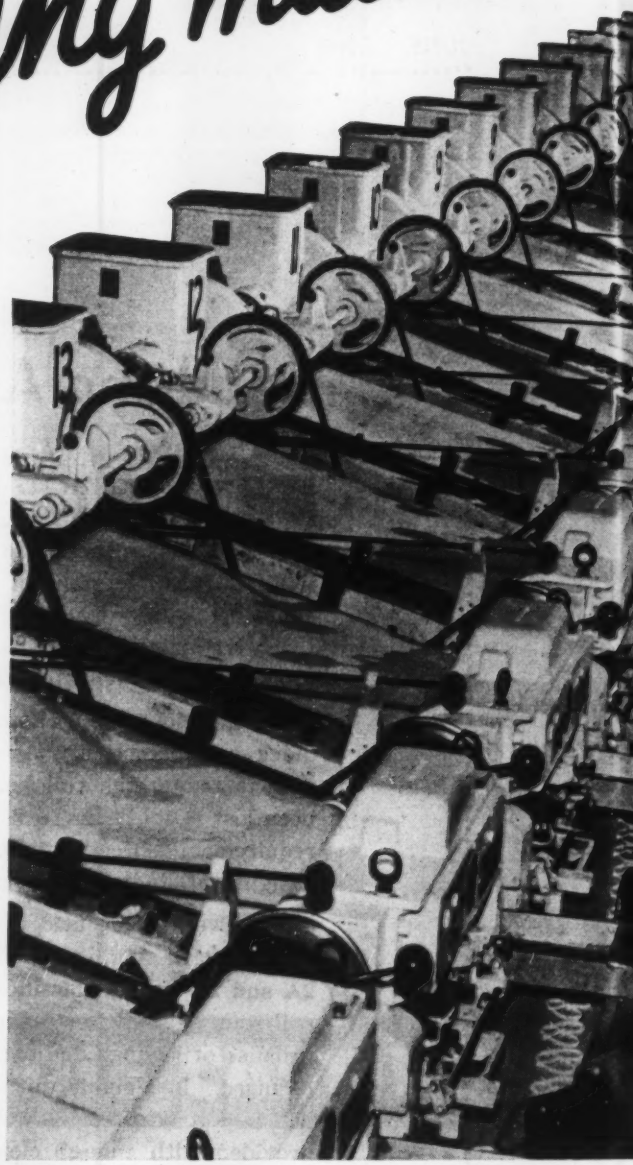


Fig. 1—Right—Pretzel tying units installed diagonally across an endless belt. Each unit feeds a row of pretzels to the baking oven

Fig. 2—Below—Extruded dough, cut off as pellets by the rotating knife, is rolled between canvas belts to form dough rods

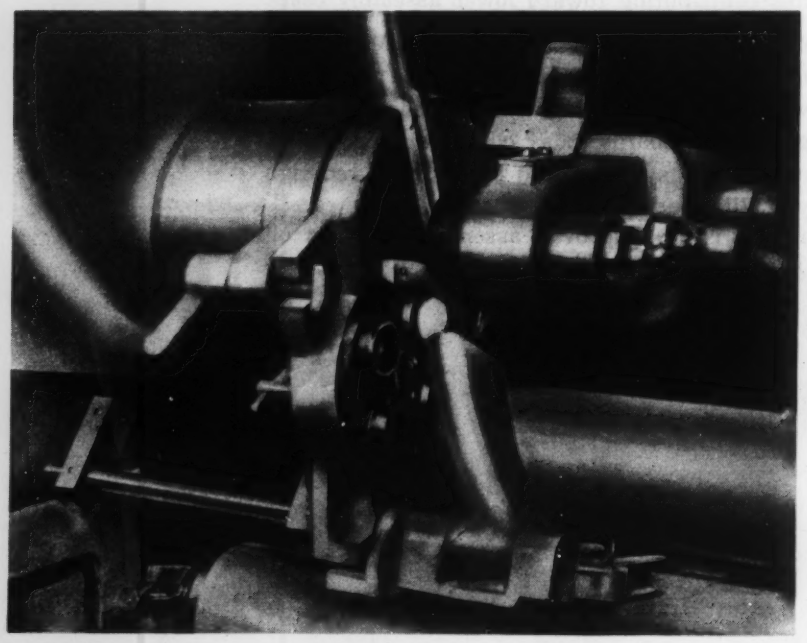
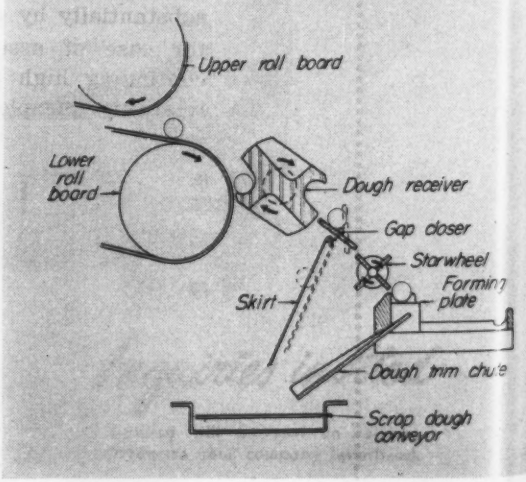


Fig. 3—Below—Transfer point where dough rod is fed into tying mechanism. Rejected dough rods and end trimmings, carried away by scrap conveyor, are put back in extruder



man, to grasp uniform-sized rods of dough and twist them into the identical knot and shape that have always characterized pretzels.

Illustrated in *Fig.* 1 is a battery of these pretzel tying machines. Each will transform a mass of dough into raw pretzels and deliver them to a moving conveyor at rates up to fifty-five per minute, twenty-four hours per day. In a typical application, sixteen such machines are mounted diagonally across a fifty-inch wide conveyor belt which carries the sixteen rows of pretzels to the cooking and baking process. Such a battery of machines will produce over four-hundred-thousand pretzels in an eight-hour day, which represents from four to seven thousand pounds of finished product, depending on the diameter of the dough rods fed to the tying heads. Weight of the pretzels is determined primarily by this dimension, as they are otherwise uniform in size and shape. By adjusting the spacing between the rolling belts which produce the rods, weights from 55 to 105 to the pound of finished product can be obtained.

Employs Battery of Unit Machines

Prominent feature of this use of multiple units is the high mechanical availability that can be achieved. A breakdown in one unit can be remedied quickly by inserting in its place a spare tying head, resulting in a minimum loss of production while repairs are being made. Each tying unit is powered through a three-jaw clutch coupling to the main line shaft, so that any one unit can be shut down independently of the rest of the battery. This shaft is supported on self-aligning bearings at each unit and is driven by a Reeves 15-hp variable-speed drive mounted at whichever end of the supporting structure suits the bakery layout best.

To facilitate quick interchange of tying heads, aluminum has been used for the supporting frames,

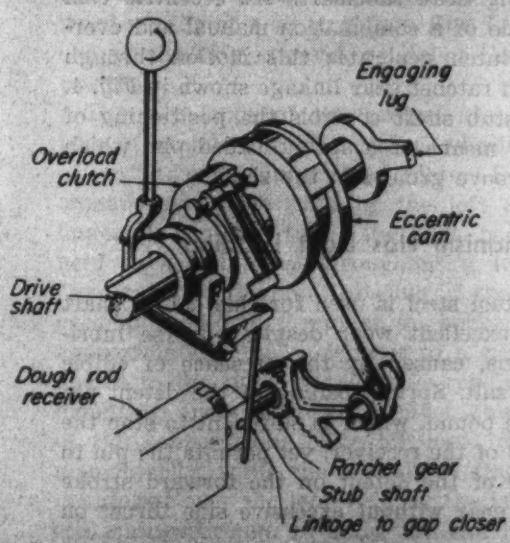


Fig. 4—Left—Detail of right-hand side of tying head, showing engaging lug, dough rod receiver drive and overload cluch

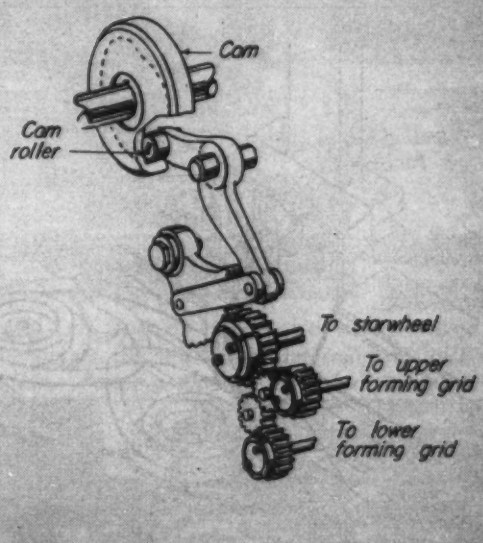


Fig. 5—Right—Left-hand side of tying head, showing generation of starwheel and upper and lower forming grid motions

gear boxes, covers and shrouding. Weight considerations were sacrificed, however, in the design of the main cams and other working parts to achieve sturdiness and long life.

In operation, the dough mixture is placed in the hopper of a screw type extruder, *Fig.* 2. A rotating selector plate provides four different sized orifices to determine the volume of the pellets from which the dough rods are formed. A lever-operated gate on the inside surface of the extruder end-plate provides a fine adjustment of this pellet volume. These adjustments, in conjunction with the variable spacing of the rolling belts, determine the length and diameter of the dough rods prior to entry into the tying mechanism.

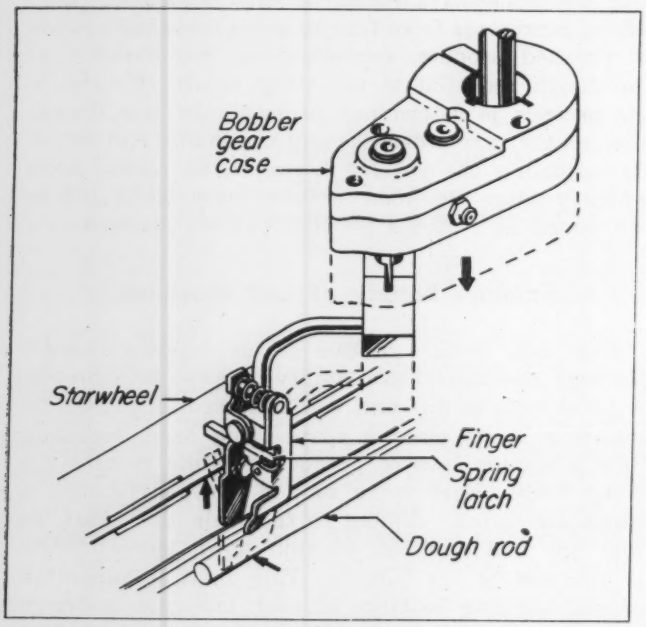
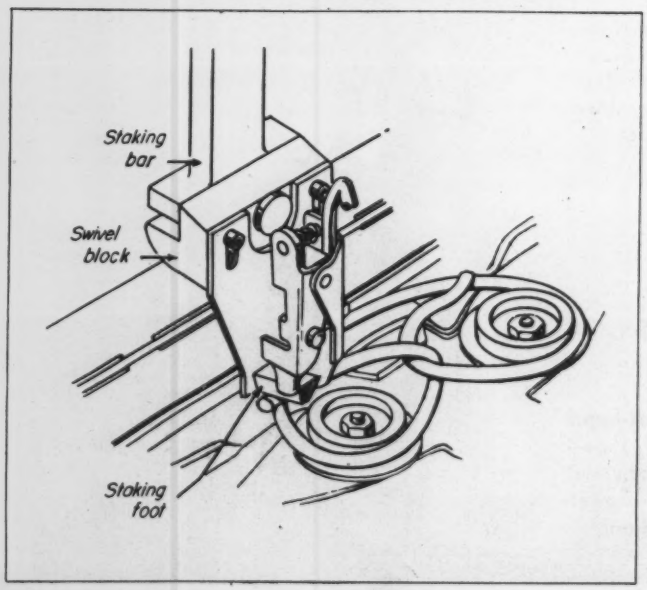


Fig. 6—Above—Lowering of the bobber gear case trips the latch lever of the finger against the starwheel to grasp the dough rod, starting the tying operation

Fig. 7—Below—Staking bar descends to press staking foot over the end of dough rod, welding it to body of pretzel. Finger is latched open by the staking foot



The relationship of the tying head and rolling belts is shown in *Fig.* 3. Since the dough-rod receiver, which is part of the tying head, must be placed as close as possible to the surface of the belts without touching them, the interchangeable tying heads are located by dowel stops in the supporting structure and a machined surface on the frame of the tying head. This permits the use of large slots in the tying heads for easy placement of two tie-down bolts.

A single engaging lug, at the right-hand end of the tying-head cam shafts, slides between two bronze bushings mounted on studs brazed into the driven face of a friction clutch at the right of each machine, *Fig.* 4. Roller chain is used to drive this clutch from a countershaft underneath the rolling belts, and also powers the dough extruder and pellet cutting knife as well as the rolling belts themselves. By momentarily slipping the friction clutch, the tying head can be timed to index with the arrival of a dough rod in the dough receiver. Once timed, the adjustment needs no further attention unless the diameter of the dough rods or the viscosity of the dough mix is changed.

Receiver Stretches Dough Rod

Dough rods are transferred from the rolling belts to the tying head by indexing of the dough-rod receiver, *Fig.* 3. This part is an aluminum casting with two grooves positioned one hundred eighty degrees apart and curved convexly over the length of the rod receiver. Shaping the grooves in this manner tends to stretch out the rolled rod of dough and removes any kinks caused when the rotating rod is released from the pressure of the belts. It also compensates for the tendency of the dough rods to drop ends-first from the belts, which is brought about by crowning of the belt pulleys.

A stub shaft, running in needle bearings in each side frame, supports the ends of the dough-rod receiver. The right-hand stub shaft indexes the receiver one hundred eighty degrees for each revolution of the tying head camshaft. An eccentric cam on the input side of a combination manual and overload-operated clutch generates this motion through the segment and ratchet gear linkage shown in *Fig.* 4. The left-hand stub shaft controls the positioning of the receiver by means of a spring-loaded pin, which drops into a groove ground in the shaft.

Mechanism Has Light Loading

A graphitic tool steel is used for this detent shaft and is giving excellent wear despite adverse lubrication conditions, caused by the presence of edible oils, flour and salt. Spring loading of the detent pin is less than one pound, which is sufficient to stop the forward motion of the receiver, yet permits the pin to be cammed out of the detent on the forward stroke of the ratchet gear without excessive side thrust on the pin sleeve.

Referring again to *Fig.* 3, the dough rod leaves the

receiver groove at the end of the receiver index and is transferred to a starwheel if the gap closer plate is in the closed position. This plate is elevated to the position shown in dotted outline to reject the rods from the tying mechanism. Dough, so rejected, is deposited on a four-inch canvas conveyor running the length of the structure and is collected for reuse in the machine. A linkage to the overloaded clutch elevates this transfer plate automatically when the clutch is disengaged to prevent pile-up of the dough in the starwheel, since the dough receiver, being driven from the input side of the clutch, continues to operate as long as the timing clutch is engaged.

Cam Indexes Starwheel

Indexing of the starwheel is accomplished in the same manner as that of the dough-rod receiver but, in this instance, power is taken from a closed-track cam, *Fig.* 5, on the left-hand end of the main camshaft. Since the starwheel indexes only ninety degrees per pretzel, the ratchet gear is larger to make possible the indexing of upper and lower pretzel forming grids by means of the gear train shown in *Fig.* 5. Dough rods are deposited directly onto the platen of the upper forming plate and grid with each index of the starwheel.

A trimmer knife at each end of the platen cuts off the execess length of the dough rod simultaneously with descent of the tying fingers. These scrap ends are also dropped down chutes to the same scrap-dough conveyor which carries away rejected dough rods.

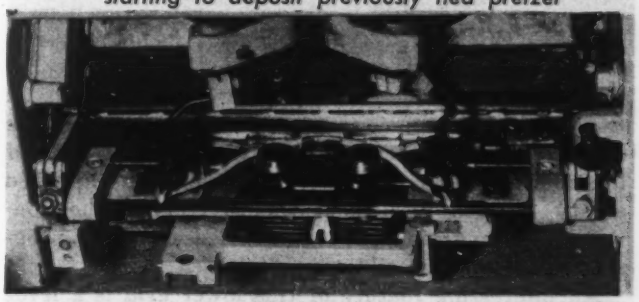
Details of the stainless-steel tying fingers and their assembly to a bobber case are shown in *Fig.* 6. Both fingers arrive over the ends of the dough rod

Fig. 8—Right—Progressive positions of fingers in tying and staking the pretzel knot

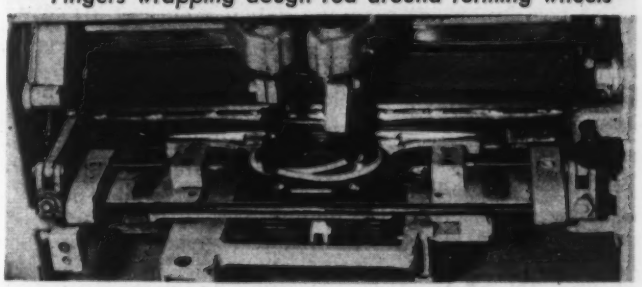
latched in their open position. Downward motion of the bobber case unlatches a spring-loaded hinge on the fingers to grasp the dough rod, while the downward motion of a staking foot, *Fig.* 7, at the opposite end of the finger travel, relatches them in the open position.

The two loops of the pretzel are bent around a pair of stainless steel forming wheels on each side of an indexing upper grid plate. Since an actual cross over in the path of the left and right-hand fingers is required to tie the knot, backlash must be held to a minimum throughout a long gear train from cams to fingers. Crossing of the finger path is accomplished by first moving the bobber cases through approximately ninety degrees to a position at right angles to the tying platen while revolving the finger mounting arms about their pivot point at the ends of the bobber cases. The left-hand finger hesitates momentarily, while the right-hand finger swings the dough rod over the loop held by the left-hand finger, continuing through to stake the end in place, which forms the right-hand loop. It then retraces its arc in

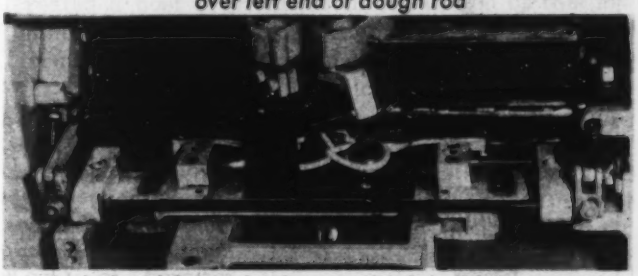
Fingers ready to grasp dough rod. Lower plate is starting to deposit previously tied pretzel



Fingers wrapping dough rod around forming wheels



Left-hand finger hesitates; right-hand finger crosses over left end of dough rod



Right-hand finger backs out of left-hand finger path to allow it to complete its arc

Above—Left end of dough rod being staked
Below—Fingers latched open, returning to pick-up position. Forming plate index is half complete

time to allow clearance for the left-hand finger. At this time, the left-hand finger completes its arc and the left-hand stake bar comes down to open the finger and complete the left-hand loop. Both bobber cases descend at each end of the finger travel to alternately pick up and deposit the ends of the dough rod. *Fig.* 8 illustrates six progressive positions of the fingers required in tying a pretzel.

Immediately after the pretzel is thus formed, the upper forming grid rotates one hundred eighty degrees, and the pretzel is deposited upside down on a lower forming grid. This second grid performs the function of tightening the knot after release of the two loops from the upper forming grid wheels. It also serves to place the pretzel on the conveyor in the best attitude for baking with the staked ends of the dough rods up, since it also indexes one hundred eighty degrees to deposit the pretzel on the conveyor. Both grids are double sided to make progressive indexing possible.

An interesting feature of this lower grid is a lever and cam attachment, which displaces it at right angles to the conveyor to lay two rows of pretzels. This is done where the speed of the baking equipment does not demand more than half of the maximum speed of the machine. Thus, an oven conveyor forty-six inches wide, traveling at a speed to take twenty-four pretzels per machine per minute, can be filled to capacity using only seven double-row machines, operating at forty-eight per minute, in place of fourteen machines operating at a reduced speed.

Wherever possible, identical parts have been used to perform like functions. Thus, the pawls and ratchets which index the dough receiver and the upper and lower forming grids are made from the same drawings, with the exception of the ratchet race of the dough receiver, which has reverse rotation with respect to the former two. Details of the ratchet gear are shown in *Fig.* 9. Driving pawls in each case are coupled directly to the end of the driven shaft, while the gear and ratchet supply the power through a segment gear and lever linkage from the actuating cams. Likewise, the positioning and holding of the indexed dough receiver, starwheel and upper and lower grids are accomplished by the same detent pin and guide assemblies throughout. This multiple use of parts is of considerable value because of the limited production of specialized machinery of this type, where the setup time in most cases is far in excess of running time.

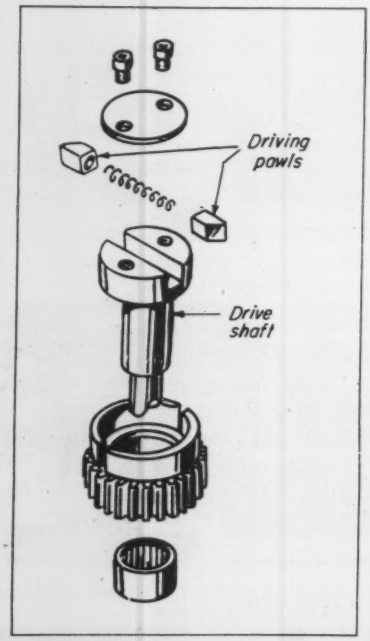


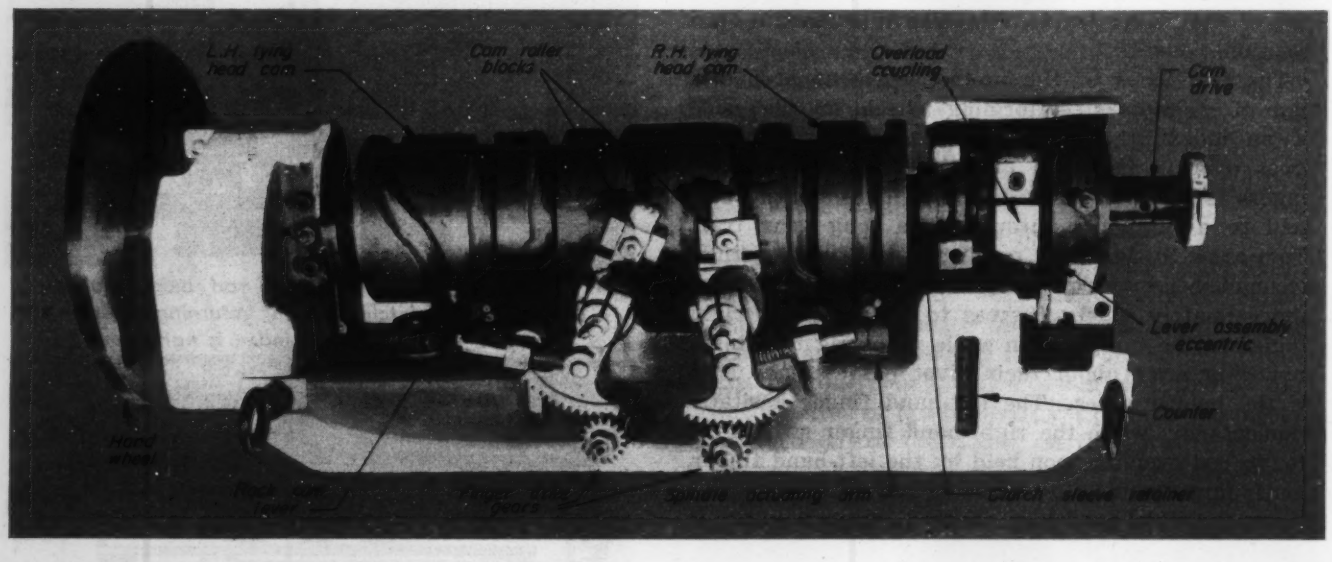
Fig. 9—Left — Typical gear and ratchet used to index the dough-rod receiver and pretzel forming grids

Fig. 10—Below — Top view of tying head, showing cylindrical cam which generates tying finger motions. Right-hand frame cap removed to show clutch detail

Camshaft Controls Finger Motions

All motions of the tying fingers and staking bars are derived from the main cam shaft, *Fig.* 10. Seven cam tracks are machined in two Meehanite castings which form the right and left sections of the assembly. Each section is pinned to the driveshaft separately, the correct relation between the two being established by keys.

An aluminum gear box in front of the cam mounts all of the levers and followers, as well as the tying fingers themselves, making this an easily interchanged assembly. Four Allen cap screws and two dowels support the box rigidly between the side frames which house the main bearings of the cam shaft. In *Fig.*



11 the cover of the gear box is removed to show the compact arrangement of parts in this small space.

The cam track at the far left in *Fig.* 10 actuates a rack extending across the driving spur and segments which rotate the bobber cases. A lever at the right-hand end of the rack attaches to the shaft of a counter to record the number of operations upon which machine rental fees are based.

Turns and Elevates Bobber Cases

The second cam track from the left and the first on the right elevate and lower the bobber cases of the tying fingers. A yoke at the end of each lever holds a pair of shoes in a track on the outer shaft of the cases. This permits the bobbers to be turned and elevated at the same time after the dough rod has been grasped by the fingers. These bobbers are mounted on and turned by an external shaft, while the finger rotation is accomplished by means of an internal shaft. The inner shafts of the bobber cases extend through the top of the gear box where they are driven by spur gears in mesh with the bronze segment. These two segments are actuated by the levers and followers seen in the top view of the cam and gear box, *Fig.* 10.

Immediately adjacent to the segments are seen the spring posts and springs which compensate for backlash in this part of the gear train. Since the spur gears raise and lower with the vertical motions of the bobbers, they subject the segment gear to more than ordinary wear. The backlash accumulation through the entire gear train from cam lever to tying fingers is held to a maximum of 0.013-inch to eliminate whipping of the tying fingers, which would cause them to drop the dough rod. To achieve this, individual gears are checked to a standard mating gear on standard centers for a maximum backlash of 0.0015-inch.

The staking bars ride in a bronze sleeve block mounted on the back of the gear box. The stamper feet which contact the dough are fastened to the staking bars through a spring-loaded swivel block, *Fig.* 7. This minimizes wear on the inner surfaces of the fingers caused by inaccurate finger stroke adjustments and permits a certain amount of backlash in the finger-operation gear train.

Overload Clutch Protects Mechanism

At the right-hand side of the main cam is located the combination manual and overload-operated clutch, *Fig.* 10. The overload feature of this clutch is of paramount importance, considering the amount of moving machinery from which the operators cannot otherwise be protected. Details of this clutch were shown in *Fig.* 4. Spring pressure on the detents holding the driving pins is adjusted to allow the clutch to disengage when a force of about twenty pounds is applied against the rotation of the bobber cases. The clutch must be reset manually by means of the hand lever and must be manually disengaged whenever the machine is not tying pretzels. Otherwise the counter would operate with each cycle of the main camshaft.

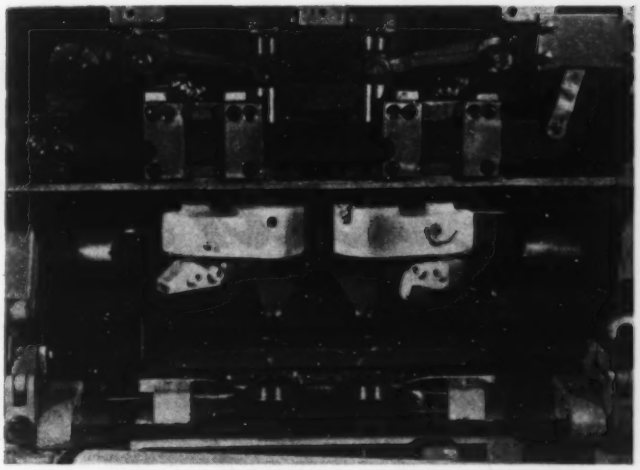


Fig. 11—Removing main gear box cover gives access to the levers and rack which elevate and rotate bobber cases

Adjacent to the left-hand end of the main cam, *Fig.* 10, is a cam which operates the dough-rod trimmer knives. This cam elevates the shear action knives at the ends of the pretzel-forming platen just rapidly enough to permit placement of the dough rod by the starwheel. However, it has an instantaneous drop-off to shear the dough ends before the fingers start to elevate and twist the end loops of the pretzel.

Necessity for a variety of intermittent, reciprocating and precisely timed motions, combined with the necessity for handling a wide range of dough mixtures under extreme variations of relative humidity, created a host of problems in the design of this machine. Also to be taken into consideration were the normal locale of the machine in atmospheres containing flour and salt, plus the fact that lubrication, protective plating and materials contacting the dough had to be scrutinized from the viewpoint of the various federal, state and local pure food laws. With the solution of these problems, the art of twisting pretzels mechanically has become another in the long list of achievements of the Machine Age.

Torsion Testing Machine

MAKING use of electrical resistance strain gages to accurately measure applied torque, a two million pound-inch torsion testing machine has been built that is capable of handling full-sized structural members such as bridge sections.

In operation, one end of the section under test is fastened to a drum and the other end to the stationary part of the tester. The drum is turned by a large press through a belt and pulley arrangement. An aluminum tube on which the strain gages are mounted is inserted at one end of the specimen to measure the torque applied.

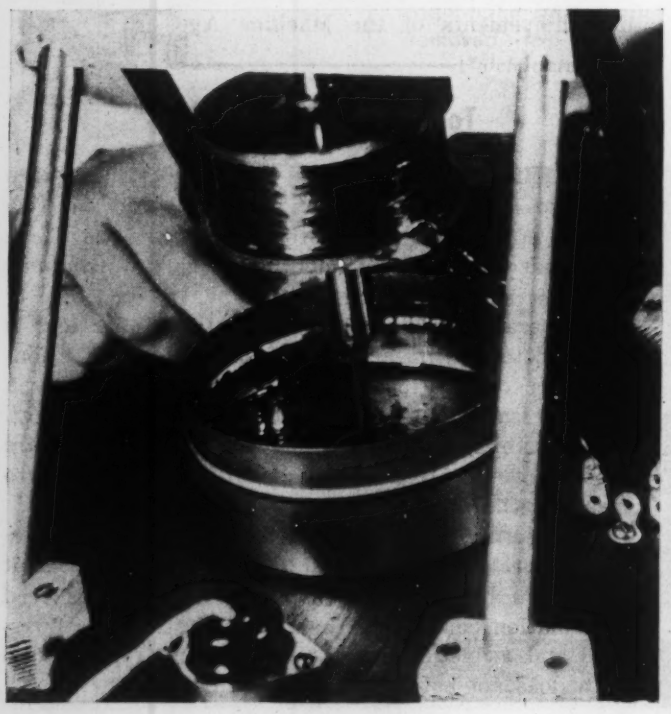
The testing unit, installed at the Fritz Engineering Laboratory of the Civil Engineering Department at Lehigh University, is expected to provide needed information concerning the torsional strength of riveted and welded built-up girders where fundamental data does not equal that of rolled beams.

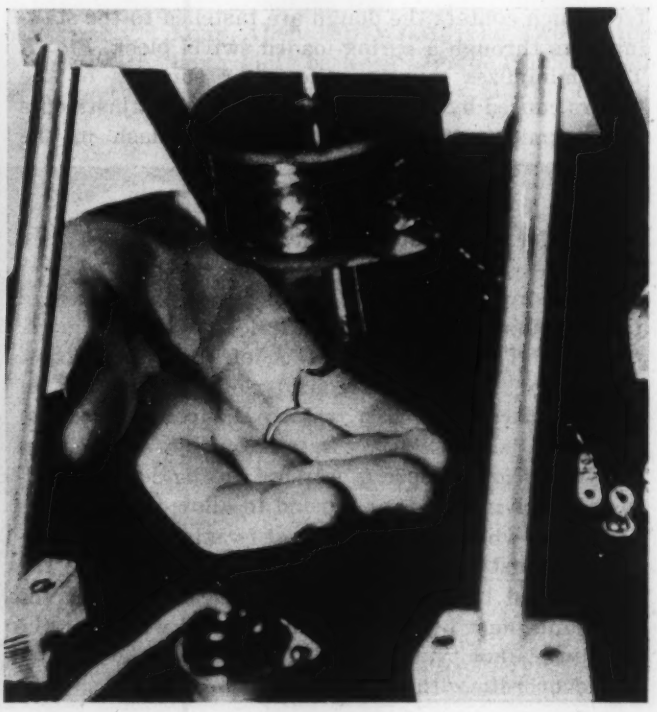
Scanning the field for Ideas

Magnetic fluids originally developed at the National Bureau of Standards for electromagnetic-fluid clutches, have unique properties that hold promise for other applications of these iron-oil mixtures. The fluid may be employed to good advantage in hydraulic systems, dash pots and shock absorbers. Also it may be used to form casting molds and as variable electrical resistors. The basic property on which all these applications depend is that the viscosity of a magnetic fluid is directly related to the strength of the applied magnetic field, causing the fluid to be changed from a liquid to a nearly solid state and back again at will.

When employed in hydraulic systems, the fluid makes valving extremely simple. Shown below is a laboratory model of a magnetic valve, formed by passing a fluid carrying tube through an electromagnetic coil. Adjusting the current in the coil controls the flow of fluid. In the left-hand photograph, the magnetic valve has no current in the coil, resulting in full flow of fluid. At the right, the current is strong enough to completely stop the flow.

In a conventional dash pot, rate of travel of the piston is usually controlled by a variable orifice. If, however, a magnetic fluid is used, the rate may be controlled by magnetically varying its viscosity. An electromagnetic coil around the dash pot controls the viscosity because it would be a function of the current in the coil. Employing this idea in the design of shock absorbers for automobiles and trucks would provide an adjustable riding quality to meet various loading and roadway conditions. Rate of response of the magnetic fluid is high enough to provide virtually instantaneous changes in viscosity, thereby making possible a shock absorber with automatic compensation.

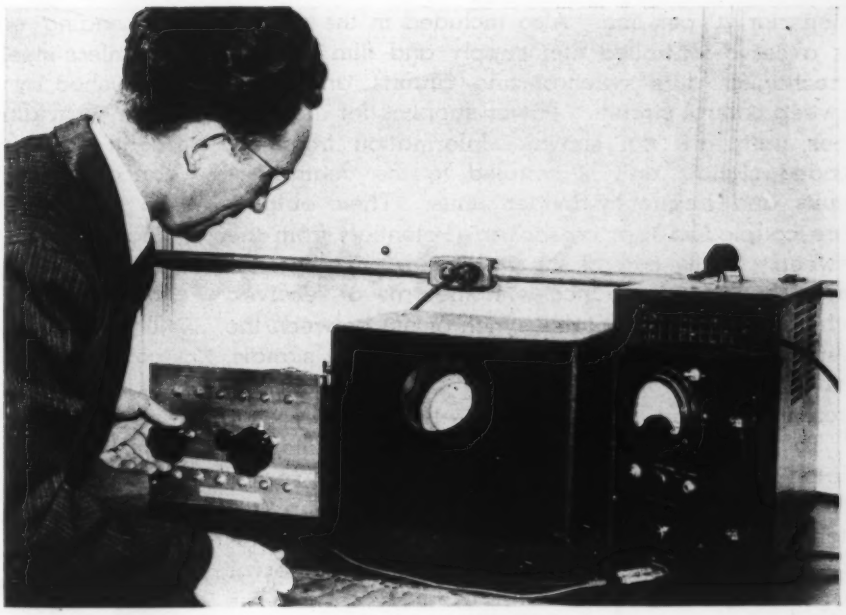


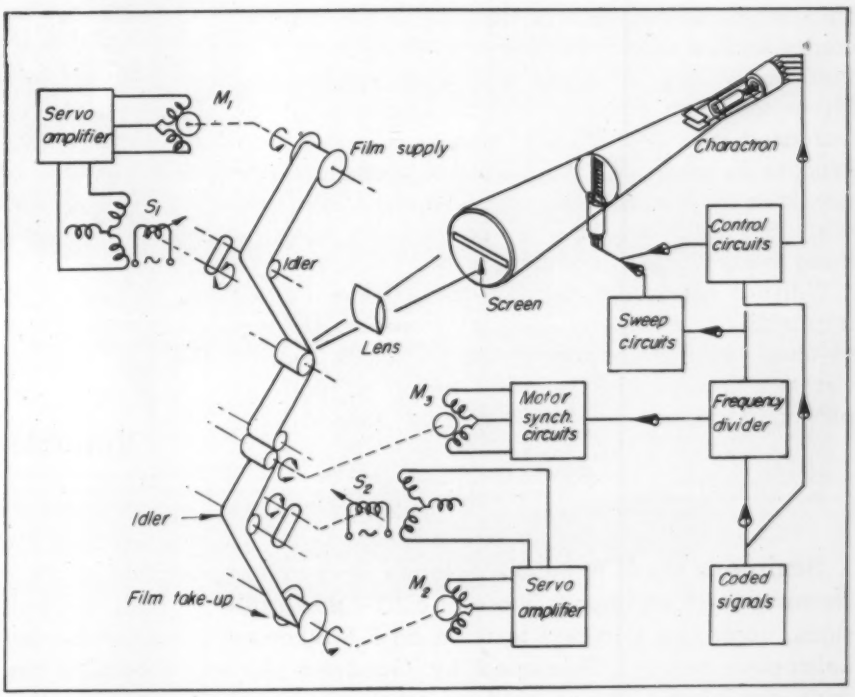


For use in casting processes, electro magnetic fluids may have promising possibilities as a molding material. The flask to be used would have an electromagnetic coil surrounding it. Fluid would solidify and take the shape of the pattern when the coil is energized, allowing removal of the pattern and providing a mold in which molding compounds may be cast. After the coil current is turned off, the molded replica may be removed from the liquid. The boiling point of the fluid must of course be higher than the temperature of the casting material.

By immersing two electrodes in a magnetic fluid an electrical resistor can be made which is adapted to remote control. When the fluid is in an unmagnetized condition, the resistance between the electrodes will be extremely high because of the loose contact among the conductive iron particles that are randomly distributed in the nonconductive oil. In the presence of a magnetic field, however, the iron particles apparently form chains along the lines of magnetic flux and draw into close physical contact. The flux density will determine the massiveness of the chain and thus the conductivity of the mixture.

Characteristics of the fluid, both of the oil and particles will have a marked effect upon the possibility of success of any application. Even as the magnetic fluid clutch (discussed previously in this section and by R. E. Elberty in the May issue) will require extensive development, so undoubtedly will the other applications of this fluid before they are commercially useful.





Ultra-high-speed electronic unit for transmitting and receiving data has reached the development stage and is expected to replace many current methods for sending and recording printed material. Known as Electrontype and invented by J. T. McNaney of Consolidated Vultee Aircraft Corp., the unit can transmit book length documents to any part of the world and will be valuable in combination with high-speed computation systems.

Main element in the unit is a Charactron, a new type of cathode-ray tube. It may also be used for reading printed matter direct from the screen of the tube. Shown at top is a demonstration unit for displaying messages on the screen in response to coded input signals. Electron shadows of predetermined characters are focused selectively on the screen. Controls at the left simulate a high-speed code transmitter. Message presentation requires a thousandth-second and may be retained on the screen for lengthy durations.

A complete recorder is illustrated schematically above. The Charactron tube displays a single line of symbols with space provi-

sions for 70 per line. Also included in the system is a servo-controlled film supply and film take-up mechanism, film synchronizing circuits, and input sweep control circuits. Power supplies for the various units are not shown. Information from the coded signals unit is coupled to the control-circuits and frequency-divider units. Their outputs are coupled in turn as shown. Potentials from the sweep circuits control the start and completion of each line in accordance with the rate of received characters. M_3 maintains synchronism between the film movement and the speed of incoming signals, and is geared down to drive the film past the screen at speeds which provides line spacing.

To keep inertia effects of large rolls of film isolated from the film synchronizing mechanism, servos are employed in the film supply and take-up systems. M_3 advances the film by friction drive wheels against a constant loading on idler wheels. Servos controlling the film magazines are identical and the drives act rapidly in response to changes in speed of incoming signals. In each case there is a synchro which senses the size of a film loop. An increase in film speed, for instance, tends to shorten the supply loop. Signals from synchro S_1 allow M_1 to feed film from the supply magazine at the increased rate. As a result of a lengthening loop, synchro S_2 allows M_2 to increase in speed until the film take-up assumes the proper speed. Idler tensions are held constant during changes such as these to exert constant loading on M_3.

With 70 exposures per line and 35-mm film, it is possible to expose 10,000 characters on 150 mm of film. At input signal speed of 20,000 characters per second, the film will travel through the printer at approximately 300 mm per second.

Stainless steel helicopter blades have lifting characteristics superior to those of conventional designs, according to recent tests on an R-5 Sikorsky helicopter, below. Developed by Goodyear Aircraft, the blades are of built-up construction and have a deicing system incorporated in their basic construction. Hot air delivered at the root of the blades is carried along its leading edge.

Leading edge assembly is 0.030-inch stretched stainless steel with no seams or splices. Support is furnished by two spanwise spars spotwelded to the skin, providing high resistance to fatigue and close control of airfoil contour. Rigidity and static balance are obtained by a spanwise strip spotwelded to the inside curve of the blade and lined with lead counterweighting. Construction behind the main spar is a cyclewelded sandwich of Formica between two sheets of 0.0015-inch stainless steel. This laminated skin covering is riveted to ribs to complete and hold the airfoil contour. Although extremely light in weight, the blade has high resistance to distortion under load.

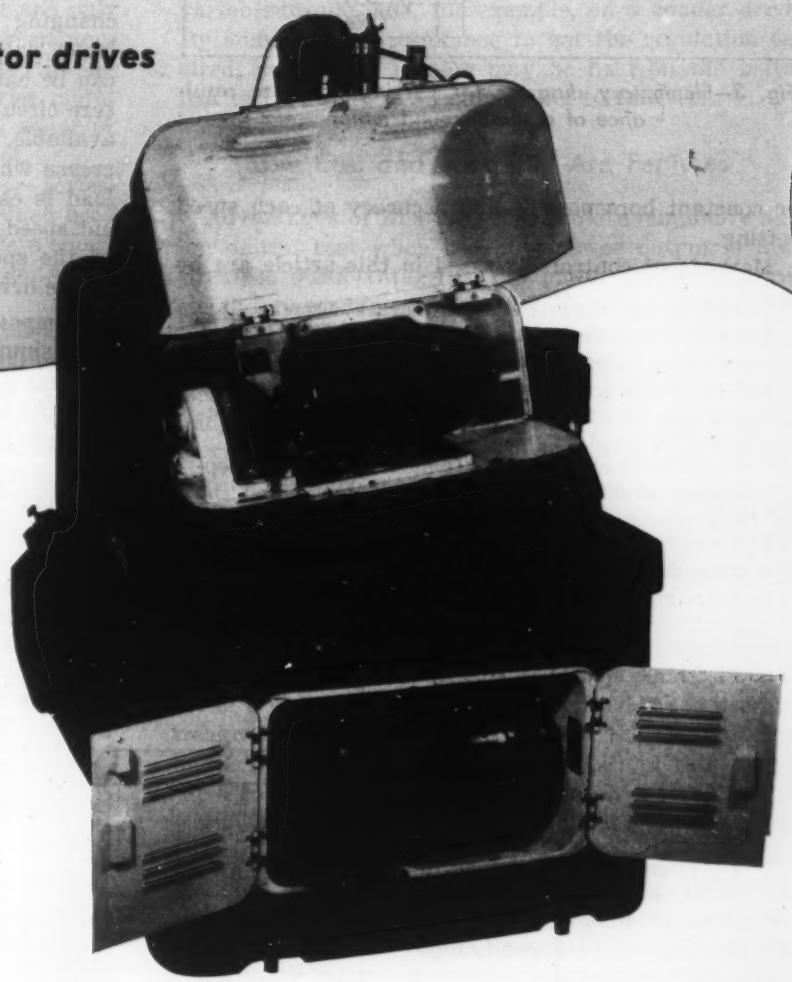
Variable-pitch rack on the Underwood typewriter, above, makes possible the typing of an even right-hand margin. Its construction, however, is such that it does not interfere with regular typing. Ends of the rack extend beyond the carriage on both the right and left sides. The right extension is for the purpose of turning the rack and the left extension has the numbers 1, 2, 3, 4, 5 and 6 stamped on it for the guidance of the operator. The rack may be turned to any one of these numbers which makes it possible to expand a typewritten line one, two or three spaces, or contract one or two spaces.

The variable pitch on the escapement rack spreads over four inches of the rack, two inches to the left and two to the right of the center of the carriage. Thus when a line is expanded or contracted the variation between each letter and space is spread over four inches and is unnoticeable.

Speed-Control Methods

for electric motor drives

By Ferris L. Reed
Design Engineer, Motor Division
Westinghouse Electric Corp.
Buffalo, N. Y.



ALTERNATING-CURRENT power being universally available to industry, low-cost a-c motors are used extensively as direct drives. Many machines, however, such as illustrated in *Fig.* 1 depend entirely upon direct-current motors for successful and efficient operation. These d-c motors are usually supplied indirectly from an alternating-current source by an a-c motor driving a d-c generator or by some other means of rectification.

Because of the electrical characteristics inherent in d-c motors, speed can be adjusted steplessly over a much greater range with a smaller amount of control apparatus and at a much lower cost than it can for a-c motors. Herein lies their great advantage. Various methods are used to control the speed of a motor. The type employed depends on the desired speed regulation, speed range, output—whether constant torque

Fig. 1—Top—Application of a special series variable-voltage drive to a Landis Tool centerless grinder. Drive has good regulation

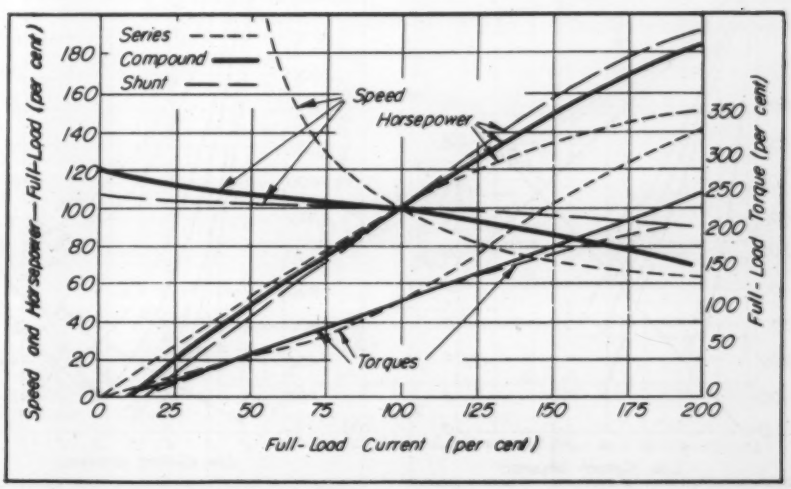


Fig. 2—Right—Typical regulation curves of shunt, compound and series motors

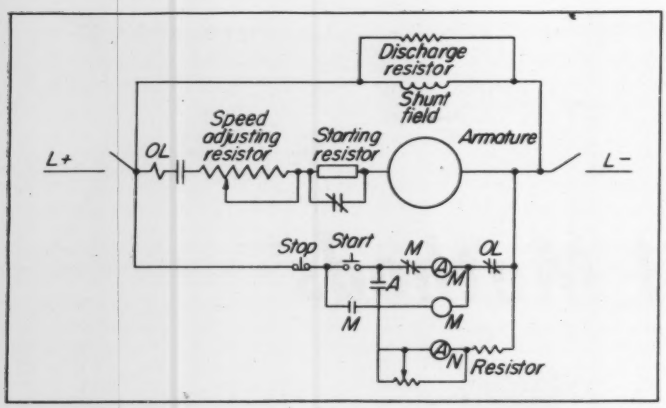


Fig. 3—Elementary diagram for varying armature resistance of a shunt-wound motor

or constant horsepower—and accuracy at each speed setting.

Methods of control discussed in this article are by

1. Adding resistance to the armature circuit
2. Field resistance, including the 4 to 1 and 8 to 1 adjustable-speed motors
3. Combination of armature and field resistance
4. Metallic rectifiers as a power supply for adjustable-speed motors
5. Adjustable-voltage drives which include the separately excited adjustable-voltage drives and the self-excited adjustable-voltage drives
6. Series variable-voltage drives and special series variable-voltage drives
7. Rotating regulators, including both the counter electromotive force and the pilot-exciter methods of speed control
8. Electronic control of applied voltage to the motor
9. Magnetic amplifier as a source of power for variable-speed motors.

ARMATURE RESISTANCE: Three standards types of d-c motors are commonly used: shunt, compound, and series-wound. *Fig.* 2 shows typical regulation curves for all three motors, giving speed, horsepower and torque characteristics.

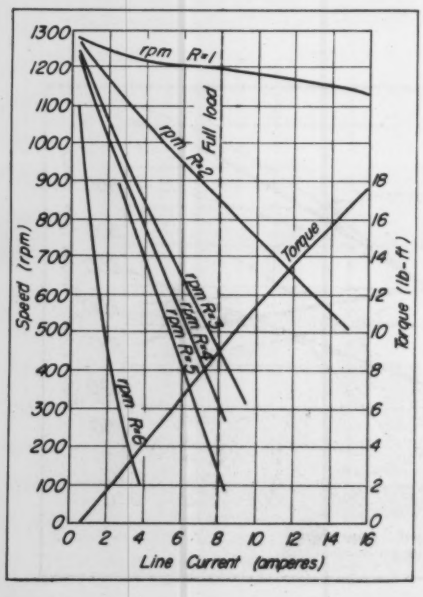
Shunt-wound motor is essentially a constant-speed motor when connected to a constant-voltage source. Now, if the field of this motor is held constant and the voltage applied to the armature is varied by adding resistance to the armature circuit, or by changing the voltage applied to the armature (the latter will be discussed later), various speed ranges can be had. By changing the resistance in the armature circuit, as shown in *Fig.* 3, a wide speed range is available, as shown in *Fig.* 4. Regulation will increase when steps of resistance are added but, if the load is essentially a constant-torque load, the different speed ranges can be set and the added regulation of the speed will have little effect on the operation of the drive.

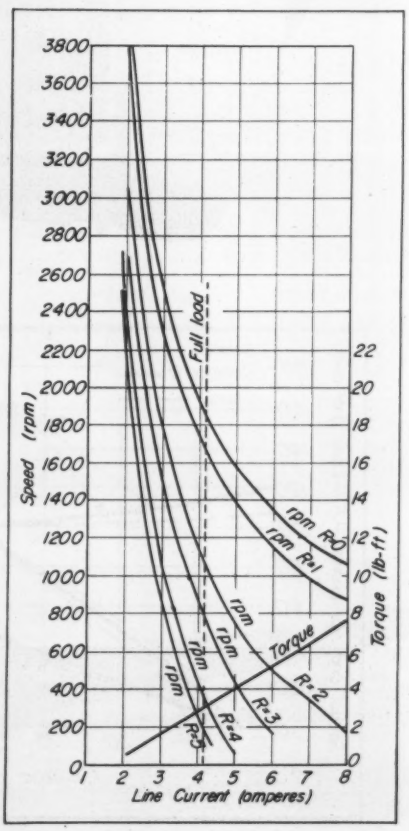
Compound-wound motor will operate much the same as a shunt motor when its speed is varied by the use of armature resistance. This motor has a higher starting torque than the shunt motor due to the added flux produced from added ampere turns in the series field. As a result, it may be used where a higher starting torque is required. The regulation will be

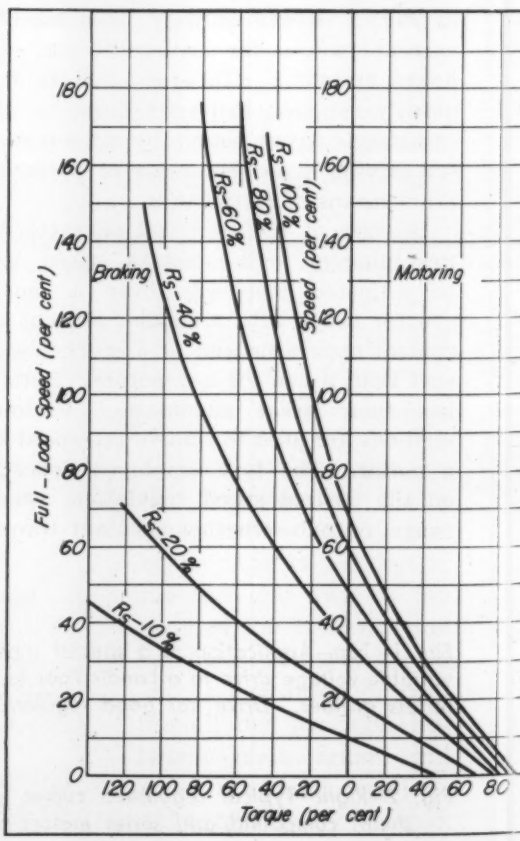
Fig. 5—Below center—Typical regulation curves of d-c series motor with resistance added to armature circuit to vary speed

Fig. 6—Below—Regulation curves of compound d-c motor using an armature shunting resistor to vary the speed of the motor

Fig. 4—Typical regulation curves of d-c shunt motor with resistance added to armature circuit to vary the speed, giving wide speed range







comparable to that of the shunt machine when resistance is added.

Series-wound motor is inherently a variable-speed machine. Its speed, however, reaches dangerous limits at light loads as indicated in *Fig.* 2. By adding resistance to the armature circuit of this motor, it too can be considered as an adjustable-speed motor, *Fig.* 5 showing typical speed regulation curves. Speed regulation is much greater with the increase in the amount of resistance added because of the voltage change due to both the change in flux and change in voltage applied to the armature with change in load. In a shunt motor, the flux remains constant and only the armature voltage would change when resistance is added to the armature circuit. Due to the increased flux with increased current, the series motor has much greater starting torque than the shunt or compound motor with lower starting current.

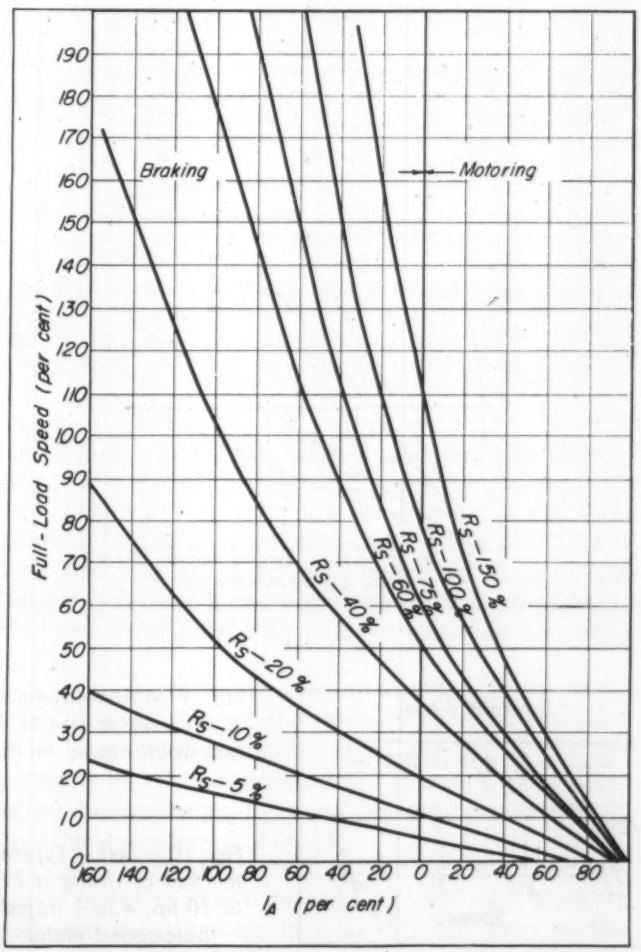
Speed range of the shunt, compound or series-wound motor may be as much as 4 to 1. When used on a variable-torque load, the curves indicate a somewhat greater range is possible. This condition would exist only if the application were correct.

Regulation of the shunt, compound and series-wound motor with resistance in series with the armature can be improved by adding a shunting resistor in parallel with the motor armature. This resistor tends to hold a better voltage regulation on the motor terminals from no-load to full-load because it loads the series line resistor. The larger the percentage of line current shunted around the motor armature the better the regulation but the lower the torque delivered by the motor.

Typical regulation curves of a compound and series-wound motor respectively, with a preset series resistor and a variable shunt resistor are shown in *Figs.* 6 and 7. They also demonstrate the effect of shunt resistors for dynamic braking as well as for improving regulation.

Armature resistance type of speed adjustment can be used on many applications which operate at a variable-torque load, for example, on a winder drive. By adding series resistance to get the regulation desired, a constant tension may be held on the mateiral to be wound from empty reel to full reel.

Fig. 7—Regulation curves of series d-c motor using an armature shunting resistor



Low Cost and Simplicity Are Features

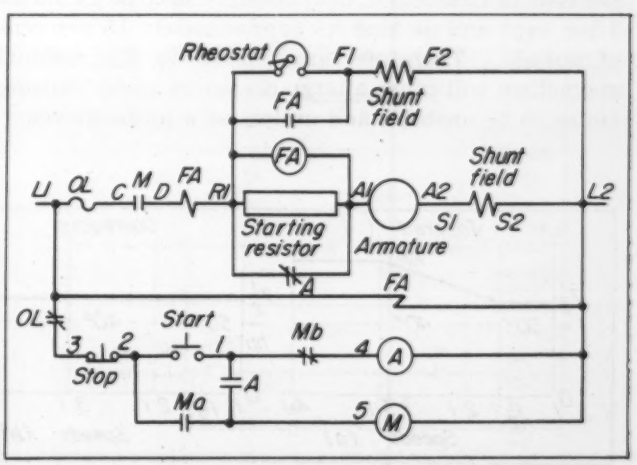
Advantages of this type of drive are simplicity and low initial cost when the horsepower output is low. Greatest disadvantage is the power lost in the resistance, power from which no gain is received. Therefore, the efficiency is very low. This type of drive would be rated continuous 40 C rise at 100 per cent load at base speed. Below base speed, the motor temperature would rise above 40 C, due to a drop off in ventilation. Therefore, at slow speeds, motor operation must be intermittent.

Control required is little more than a standard starter. The resistance can be used as the starter, but must be able to withstand continuous operation at any setting.

FIELD WEAKENING: Probably the most widely used method of speed adjustment is accomplished by weakening the field on a d-c motor. A rheostat is used to weaken the field, thus decreasing the flux in the motor. Two types of d-c motors fall in this class: the 4 to 1 and 8 to 1 adjustable-speed motors.

Four-to-one adjustable-speed motor circuit, *Fig.* 8, consists of a simple control for starting and a rheostat for weakening the field to increase the speed above base speed. Motor construction is similar to the standard shunt motor, except that it is operated much more saturated at base speed than a standard

Fig. 8—Control circuit for a 4 to 1 adjustable-speed motor



motor. This is necessary, because at 400 per cent speed, or weak field condition, the flux is only 25 per cent of full-field flux and, at this point, the residual flux is a large percentage of the flux in the machine. As the base-speed flux is greater in a 4 to 1 than in a standard constant-speed motor, the residual flux is a smaller percentage at high speed in a 4 to 1 speed motor. If a standard constant-speed motor is used for 4 to 1 speed range, it tends to be unstable at the weak field condition due to the residual flux and does not operate satisfactorily.

Typical performance curve of the 4 to 1 adjustable-speed motor from 400 to 1600 rpm is shown in *Fig.* 9. Regulation is flat at base speed and increases as speed increases to approximately 10 per cent at 400 per cent of base speed.

This motor can be rated as tapered, continuous or constant horsepower for one hour, as shown by *Fig.* 10. The tapered horsepower rated motor will deliver greatest horsepower at the higher speed ranges at rated temperature. The motor should not be used as a constant-torque drive without proper consideration. As can be seen by *Fig.* 9 the torque decreases as speed increases, because the torque varies directly as the flux with the same load current in the armature.

Braking and Reversing May Be Added

Dynamic braking can be used with an adjustable-speed motor by simple additions to the standard starting control. Reversing can be accomplished by adding reversing contactors to the standard control circuit, thus making the motor ideal for use on machine tools, such as lathes, boring mills and grinders where a 4 to 1 speed range is sufficient. *Fig.* 11 shows a typical control circuit including reversing and dynamic braking that can be used with the standard 4 to 1 speed range motor.

Eight-to-one adjustable-speed motor is the newest of the various methods of adjusting the speed of a d-c motor by field weakening, being introduced about 1945. The main factors that limit the range of an adjustable-speed motor are changes in residual magnetism, armature distortion, and demagnetization of the main field by the armature. *Fig.* 12 shows a typical hysteresis loop for a direct-current machine. From this curve, it can be seen that for 12½ per cent of normal flux, which is the flux necessary for 800 per cent of base speed, field strength may be as low as 3 per cent and as high as approximately 15 per cent of normal. Therefore, any change in the residual magnetism will cause a large change in speed, causing motor to be unstable and useless as a prime mover.

By use of a special field circuit, where the flux in each field is not reduced to 12½ per cent but where the total effective flux is 12½ per cent of base-speed flux, the effect of the change in residual magnetism is reduced, making it possible to get such a speed range.

To obtain the 8 to 1 speed range, two fields, F_1F_2 and F_3F_4 are used, *Fig.* 13. F_1F_2 field is excited from a constant-voltage source and the current in this field is held constant. The F_1F_2 coils are identical on poles 1 and 2, but are of a different number of turns on poles 3 and 4. As can be seen in *Fig.* 13, the polarity of the poles, due to these coils, is south for 1 and 4, and north for 2 and 3. The other set of coils, F_3F_4, is used to vary the speed of the motor by changing the amount of current with a rheostat in series with this field. The F_3F_4 coils on poles 1 and 2 are similar to the F_1F_2 coils on the same poles. The F_3F_4 coils on 3 and 4 are similar to the F_1F_2 coils on these poles. It can be seen from *Fig.* 13 that the polarity of the poles in order is south, north, south, and north, and that the flux supplied by the two coils on poles 1 and 2 add accumulatively, while on poles 3 and 4, the polarity of the F_1F_2 coils are differential to F_3F_4 coils.

At 100 per cent base speed, all poles are at 100 per cent field-strength flux, *Fig.* 14. Then, by weakening

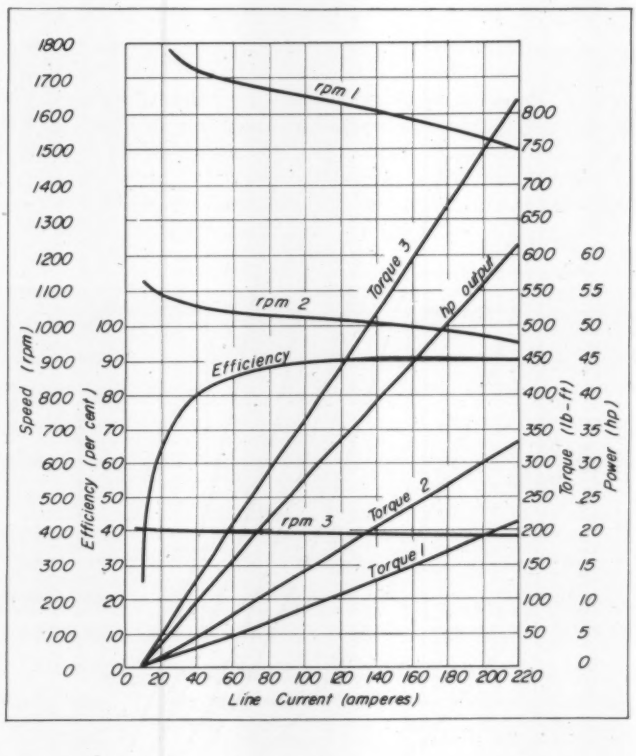


Fig. 9—Above—Regulation curves of a 4 to 1 adjustable-speed motor

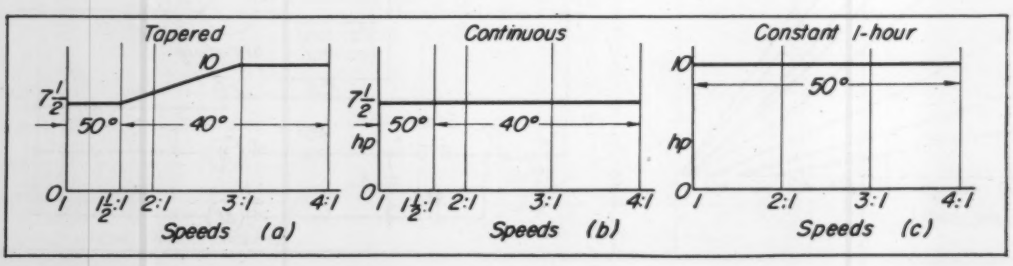


Fig. 10 — Left — Typical method of rating a 7½ to 10-hp, 4 to 1 adjustable-speed motor

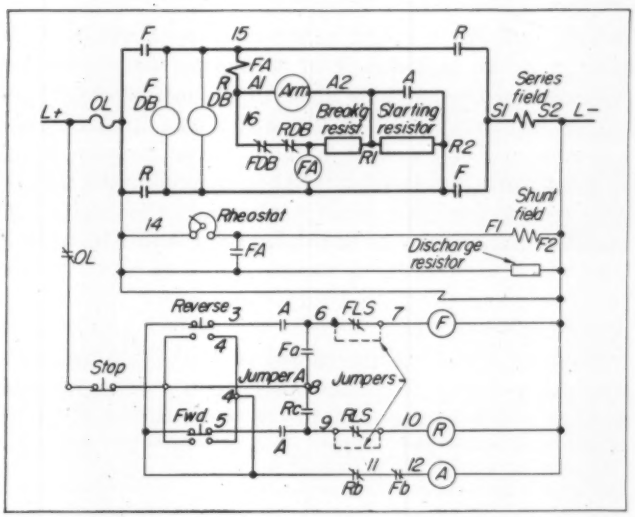
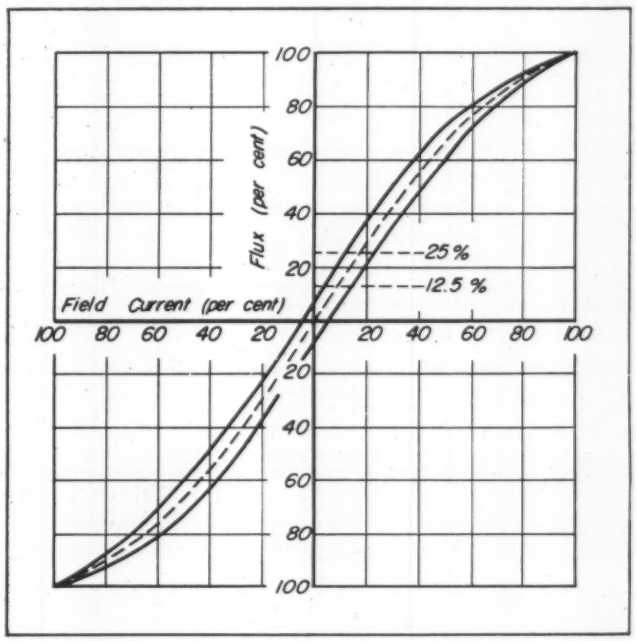


Fig. 11—Above—Typical control circuit for 4 to 1 adjustable-speed motors, incuding reversing and dynamic braking

Fig. 12—Below—Typical hysteresis loop for a d-c motor



the field strength of F_3F_4 with the rheostat, poles 1 and 2 are weakened to 82 per cent flux and poles 3 and 4 to 19 per cent flux at 200 per cent base speed, *Fig.* 14; at 400 per cent base speed, poles 1 and 2 are weakened to 67 per cent flux and 3 and 4 to −17 per cent flux. When speed is increased to 800 per cent base speed, poles 1 and 2 are weakened to 60 per cent flux and poles 3 and 4 to −35 per cent flux, as shown in *Fig.* 14.

A typical schematic control diagram is shown in *Fig.* 15, control being the same as for a conventional 2 to 1 or 4 to 1 adjustable-speed motor. The rating of the 8 to 1 is the same as the standard adjustable-speed motor, being rated as tapered, continuous or constant-horsepower, *Fig.* 16.

Typical regulation curve of an 8 to 1 adjustable-speed motor is shown in *Fig.* 17. The regulation at any one speed setting is relatively flat even at the weak-field condition. As speed is varied by weakening the field in this type of motor, it is essentially a constant-horsepower drive and should not be used to take the place of a constant-torque drive without proper consideration.

Because of the large variation of speed range possible with the 8 to 1 adjustable-speed motor, it lends

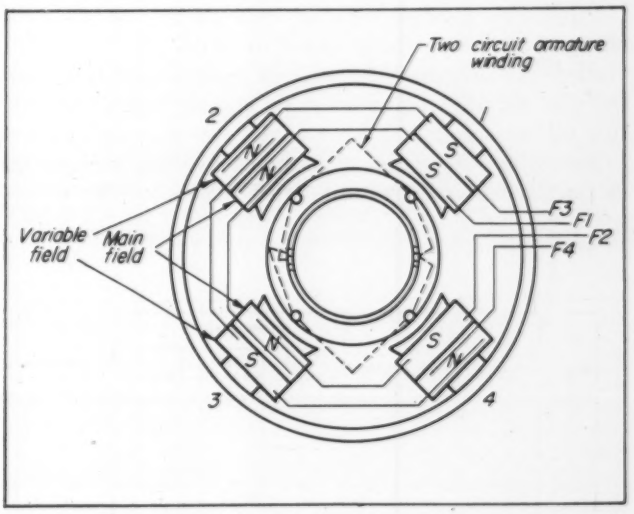


Fig. 13—Above—Two fields on each pole, showing their magnetic polarity due to each field winding when both fields are at 100 per cent field, base speed of motor

Fig. 14—Below—Per cent flux in each pole and total for motor at various speeds from base speed to 800 per cent

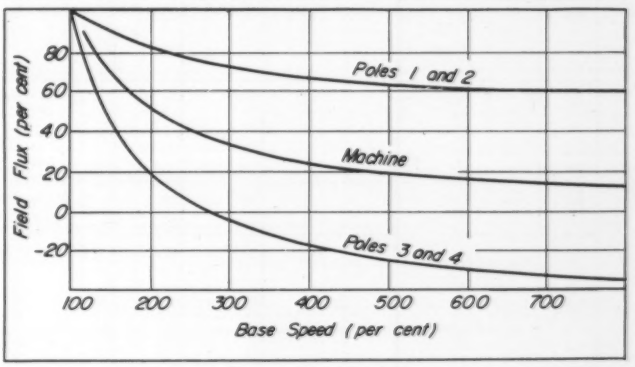
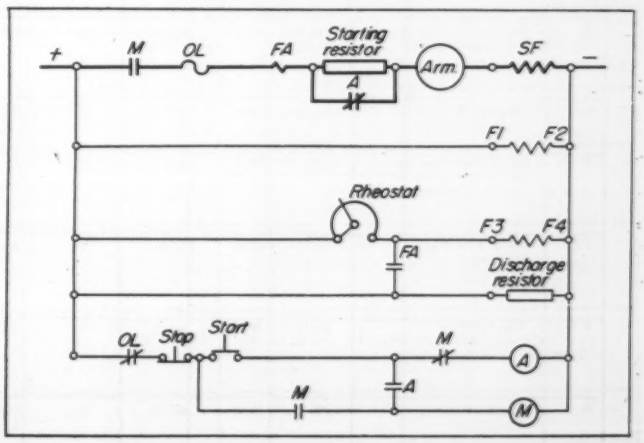


Fig. 15—Below—Typical control diagram for an 8 to 1 adjustable-speed motor



itself well to use on grinders, lathes and milling machines. It can also be used on winder drives, where the motor field is excited by a rotating regulator that measures the speed of the material being wound on a reel and supplies the proper field so as to hold a constant tension. This method will work satisfactorily where the change in diameter of the reel is as much as 8 to 1.

Until the development of this motor, speed was changed by a system of gears or belts, or a variable-voltage motor-generator set was used to supply power for the driving motor when a greater range than 4 to 1 was necessary.

Advantage of speed adjustment by field weakening is that speed is adjustable with little sacrifice in efficiency, giving a speed range of 4 to 1 and 8 to 1 with only the adjustment of a rheostat which can be mounted on the machine close to the operator.

COMBINATION OF ARMATURE AND FIELD RESISTANCE: Looking at *Figs.* 4, 6, 9, and 17, it can be seen that, if speed variation is accomplished by combining armature resistance and field weakening, the range of speed variation may be increased from 4 to 1 by armature and 4 to 1 by field weakening to as much as 16 to 1 by using the 4 to 1 adjustable-speed motor and a varying torque load.

Regulation curves are shown in *Fig.* 4 for the typical shunt-wound constant-speed motor when resistance is added to the armature circuit, the shunt field being held constant. This gives a range of approxi-

TABLE I—Comparison of Wide

No.	Type of Drive	Speed Range			Speed Regulation Order	HP Range	Exciter	Typical Application	Braking	
		Volt Control	Field Control	Total					Dynamic	Regenerative
1	Arm. Res. Shunt Motor	4/1	0	4/1	14	Up to approx. 50 hp	No	Winder drives, fans and blowers	Yes	Yes, but not very effective at slow speeds
1A	Arm. Res. Series Motor	8/1	0	8/1	17	Same as 1	No	Cranes, hoists, etc.	Yes	No
2	Field Weakening 4 to 1 Motor	0	4/1	4/1	9	Any size	No	Lathes, boring mills, grinders	Yes	Yes
2A	Field Weakening 8 to 1 Motor	0	8/1	8/1	10	Any size	No	Machine tools and winder drives	Yes	Yes
3	Comb. of Arm. Res. & Field Weakening 4 to 1 Motor	4/1	4/1	16/1	15	Up to Approx. 50 hp	No	Applications with constant load	Yes	Yes, but not very effective at slow speeds
3A	Comb. of Arm. Res. & Field Weakening 8 to 1 Motor	4/1	8/1	32/1	16	Up to Approx. 50 hp	No	Applications with constant load	Yes	Yes, but not very effective at slow speeds
4	Metallic Rectifier as Power Supply 4 to 1 Motor	0	4/1	4/1	12	15 hp	No	Lathes, boring mills, grinders, or an application where variable speed is req. with only an a-c power supply	Yes	No
4A	Same as 4 except 8 to 1 Motor	0	8/1	8/1	13	15 hp	No	Same as 4	Yes	No
5	Sep. Exc. Adj. Voltage Drive 4 to 1 Motor	10/1	4/1	40/1	4	Any size	Yes	Hoists, steel reversing mills, sectional paper drive strip steel rolling mills	Yes	Yes
5A	Same as 5 except 8 to 1 Motor	10/1	8/1	80/1	5	Any size	Yes	Same as 5	Yes	Yes
5B	Self Exc. Adj. Voltage Drive 4 to 1 Motor	4/1	4/1	16/1	7	15 hp	No	Machine tool spindle drives	Yes	Yes
5C	Same as 5B except 8 to 1 Motor	4/1	8/1	32/1	8	15 hp	No	Same as 5B	Yes	Yes
6	Series Variable Voltage Drive	10/1	0	10/1	11	Up to 15 hp	No	Dye jigs, dye cans, fans, padders, slashers, sanforizers, conveyors and washers	Yes	No
6A	Special Series Voltage Drive	10/1	0	10/1	6	Up to 15 hp	Special supply	Centerless grinder	Yes	Yes
7	Rotating Regulator EMF Method	60/1	2/1	120/1	2	Any size	Yes	Planer drives, elevator drives, ship hoist drives, winder drives	Yes	Yes
7A	Pilot Exciter Method	60/1	2/1	120/1	1	Any size	Yes	Paper machines, wind tunnels, steel mills, textile machinery, dynamometers	Yes	Yes
8	Electronic Control	20/1	4/1	80/1	3	Up to 25 hp	No	Lathes, grinders, slotters, gear cutting machines, wire shakers, rotary cutters	Yes	No
9	Magnetic Amplifier	15/1	4/1	60/1	3	Up to approx. 5 hp	No	Lathes and grinders	Yes	No

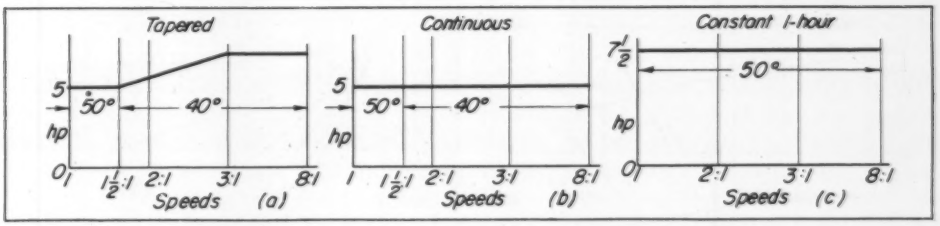


Fig. 16 — Typical method of rating a 5 to 7½-hp, 8 to 1 adjustable-speed motor

mately 4 to 1. Now, by taking this same motor and weakening the field strength to 66 per cent of its full field, regulation of approximately 6 to 1 can be had by adding armature resistance, as shown by *Fig.* 18. By weakening the field strength to 50 per cent of its full-field value, the regulation can be increased to 8 to 1, as shown by *Fig.* 19, when used on varying torque load. Many shunt-wound constant-speed motors can be made into an 8 to 1 adjustable-speed motor as most shunt-wound motors will remain stable

Wide peed Range Electrical Drives

Characteristics of Drive	Type Loads	Method of Reversing	Advantages	Disadvantages
Variable torque	Varying	Contactors	Very simple and cheap method of varying the speed of d-c motors	Low efficiency and poor regulation
Constant torque	Constant	Contactors	Cheap, larger starting torque than 1, otherwise same as 1	Same as 1
Constant hp	Varying	Contactors	4 to 1 range without special type drive	Limited speed range and regulation increases at weak field
Constant hp	Varying	Contactors	8 to 1 range, otherwise same as 2	Same as 2
Comb. of constant hp and constant torque	Constant	Contactors	Simple method where large range of speed is desired and d-c is available, and regulation not important	Same as 1
Same as 3	Constant	Contactors	Same as 3 except range increased to 32 to 1	Same as 1
Constant hp	Varying	Contactors	4 to 1 range available where only an a-c source exists, small amount of mounting space	Limited speed range, increased regulation at weak field, no regenerative braking
Constant hp	Varying	Contactors	Same as 4 except range increased to 8 to 1	Same as 4
Constant torque to base speed of motor. Constant hp above base speed	Varying	Reversing shunt field	Much better regulation than 3 where load fluctuates for 40 to 1 range	Machines increased from 1 to 4 (a-c motor, d-c exciter, d-c generator, and d-c motor) to get 40 to 1 range
Same as 5	Varying	Same as 5	Much better regulation than 3A under fluctuating load for 80 to 1 range	Same as 5 except range of 80 to 1
Same as 5	Varying	Contactors	Very simple drive for a range above 8 to 1 and below 40 to 1	Smaller speed range and poorer regulation than 5
Same as 5	Varying	Contactors	Very simple drive for as much as 32 to 1 range	Smaller speed range and poorer regulation than 5A
Constant torque and high starting torque loads	Varying	Contactors	High starting torque, good speed regulation over 10 to 1 range	Poor regulation at light load
Constant torque	Varying	Contactors	Better regulation than 6, regenerative braking possible	Increased amount of control required.
Constant torque, over varying variable-voltage range. Constant hp over field control range	Varying	Reverse field	High starting torque, wide speed range, good regulation at all speeds	Number of machines increased to 5 and more complicated control required
Same as 7	Varying	Same as 7	Very accurate speed regulation on entire range	One extra machine added to 7.
Constant torque, over varying variable-voltage range. Constant hp over field control range	Varying	Contactors	Good regulation, free from vibration, small mounting space	Size of d-c motor increased one frame size because of increased losses due to a-c ripple on the direct current supplied to motor
Same as 8	Constant	Contactors	No tubes or rotating parts	Slower response than electronic drive

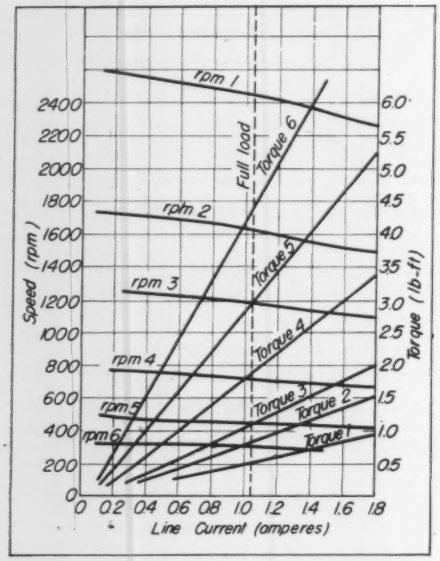


Fig. 17—Speed and torque curves of a ¼-hp, 230-volt, 300 to 2400-rpm adjustable-speed motor

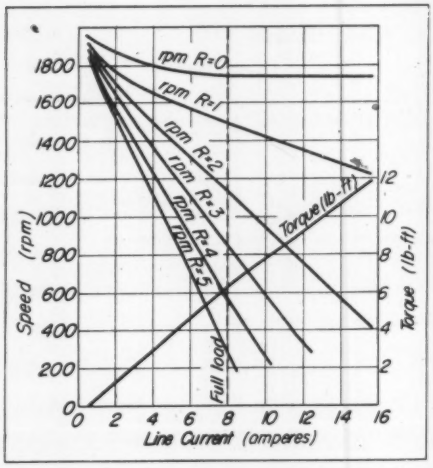


Fig. 18—Typical speed regulation of a standard shunt motor with shunt field at 66 per cent field strength, speed adjustment by adding armature circuit resistance. Regulation of 6 to 1 is obtained

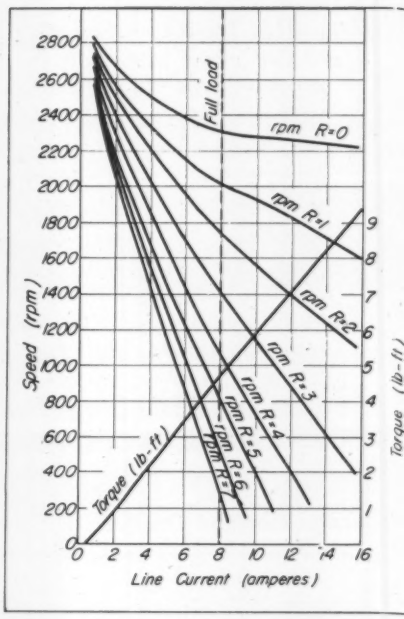
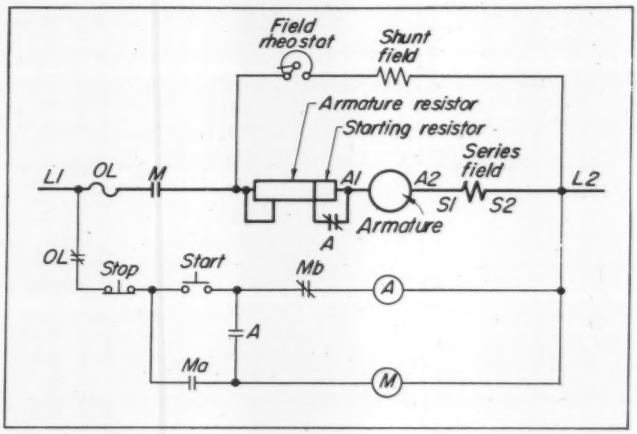


Fig. 19—Above Right—Typical speed regulation of a standard shunt motor with shunt field set at 50 per cent field strength and speed adjustment by adding armature circuit resistance to the system

Fig. 20—Below—Schematic diagram for combination of field-weakening and armature-resistance method of speed control by adding a field theostat



up to two times base speed by weakening the shunt field to 50 per cent full-field strength.

Since torque is directly proportional to the flux in a motor at 100 per cent load current, this type of speed control cannot be considered either a constant-torque or a constant-horsepower drive over its entire range. At any of its various field-strength settings and no resistance in series with the armature, the motor is a constant-horsepower drive.

Speed varies inversely as the flux and torque varies directly with the flux. For example, a 50 per cent decrease in flux or field strength doubles the speed and halves the torque, the horsepower remaining constant at 100 per cent full-load current. Now, by adding armature circuit resistance at any one field setting, the torque will remain constant over any one setting of armature current, and the horsepower will decrease in the same ratio as the speed.

The regulation curves in *Figs.* 4, 18, and 19, are for a standard constant-speed shunt-wound motor and show a speed range of approximately 4 to 1. By using the 4 to 1, or the 8 to 1 adjustable-speed motor, the range can be increased to 16 to 1 and 32 to 1, respectively.

Requires a Field Rheostat

Control required for starting is simple as can be seen by reference to *Fig.* 3, which is the control circuit required for a motor with armature circuit resistance. The only addition necessary would be a field rheostat in the shunt-field circuit, as shown in *Fig.* 20. This would increase the speed range from 4 to 1 to 8 to 1, with the standard shunt-wound constant-speed motor, or 16 to 1 and 32 to 1 with the 4 to 1 and 8 to 1 adjustable-speed motor.

As this type of speed adjustment is neither constant torque nor constant horsepower over its entire range, the problem of heating will be determined by the load current, rather than by the torque or horsepower required to pull the load attached. The motor, when operated under these conditions, should be rated at 100 per cent armature current continuously at base speed of motor and above. When operated below base speed, it should be on intermittent duty, base speed being the speed stamped on the nameplate for rated voltage.

This type of speed adjustment will be satisfactory for application to reel drives, and other drives where load and speed are set. Because of the large regulation which is caused by the change in voltage drop on the resistor, this method of speed regulation would not be satisfactory for varying loads except on special applications.

METALLIC RECTIFIERS: Use of the metallic rectifier as a power supply for d-c motors has been introduced recently into practical use. This type of package unit can be used as the power supply for 2 to 1, 3 to 1,

4 to 1, and 8 to 1 adjustable-speed motors that use the field resistance method of speed control. *Fig.* 21 compares regulation curves for a 4 to 1 adjustable-speed motor having its power supply from either a constant voltage d-c source or a metallic rectifier. As can be noted from the curves, the regulation is nearly the same for the rectifier supply as when a constant-voltage d-c source is used.

Speed variation in this type of drive is controlled by a field rheostat that weakens the shunt field of the motor in the same manner as on the standard 4 to 1 speed motor used on straight direct current.

By taking advantage of the natural internal resistance of the metallic rectifier, the d-c motor can be started across the 230-volt line even at weak field, thus dispensing with the starter required on other constant-voltage drives and reducing the control required to a minimum. *Fig.* 22 shows the schematic diagram for a small size metallic rectifier power pack. It is possible on lower horsepower sizes (1 to 7½) to dispense with all control except a breaker for connecting transformers to the a-c line and a rheostat for weakening the field of the motor. Where dynamic braking is required, the simple control shown in *Fig.* 23 can be added. If reversing is required, reversing contactors can be added to the control scheme.

Overall performance of a metallic rectifier drive is shown in *Fig.* 24. Power factor is in the region of 98 per cent compared with approximately 85 per cent on a motor-generator set, and the overall efficiency is 60 per cent or better, which is of the order of that for a motor-generator set. The metallic power pack has been developed for the 1, 3, 5, 7½, 10, and 15-hp ratings and is available for 230 volt d-c output, using any of the conventional a-c three-phase system voltages normally found in industrial plants.

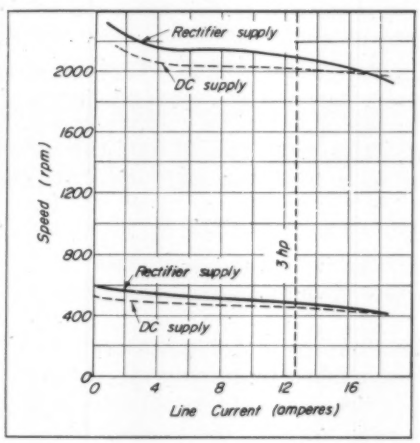
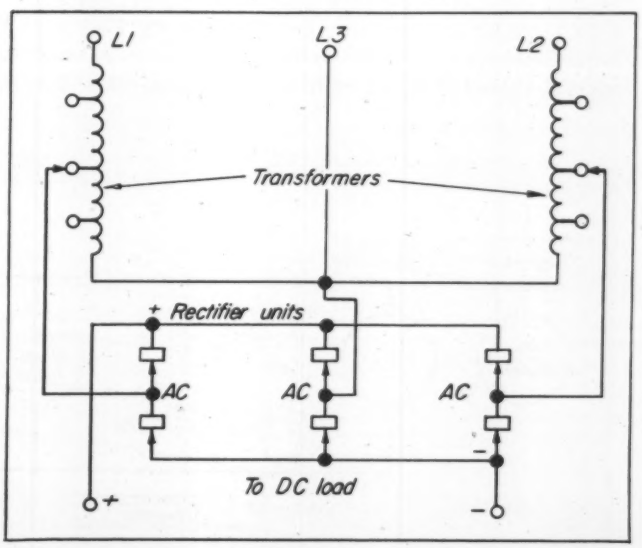


Fig. 21—Left—Speed regulation curve of a 3-hp, 500 to 2000-rpm adjustable-speed motor

Fig. 22 — Below — Schematic diagram for small size selenium cell power pack



Rectifier Can Be Mounted Conveniently

One of the advantages of this drive is that the power pack can be mounted in any out-of-the-way location. The d-c motor used with this drive has the same frame size and rating as that used on straight direct current, the ripple from the rectified a-c voltage and current having little effect on the temperature of the motor.

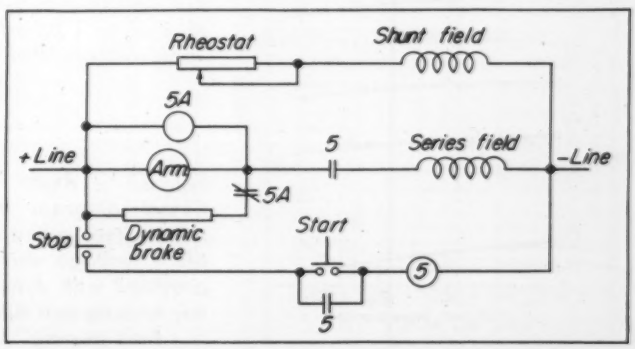
The motor output will be constant horsepower and can be used for any application that is suitable for a conventional 4 to 1 or 8 to 1 motor, operated on constant voltage with speed varied by field control.

ADJUSTABLE-VOLTAGE DRIVE: Two methods of obtaining speed variation are used: Separately-excited adjustable-voltage drives and self-excited shunt adjustable-voltage systems. In the separately-excited drive, both the d-c motor and d-c generator shunt fields are excited from a separate d-c source, usually a d-c exciter driven by the main motor generator set. In some cases, a metallic rectifier or an electronic rectifier can be used to supply the direct current for the fields by rectifying the a-c power that, in most cases, is used to drive the motor-generator set. *Fig.* 25 shows a diagram of the conventional adjustable-voltage drive.

Usually a standard shunt wound d-c motor is used. In some cases where an increased starting torque is required, a compound motor is used but this increases the amount of regulation of the motor. The motor is usually operated at full field.

A standard shunt or compound-wound generator is used to supply the power for the motor. Speed adjustment is accomplished by varying the voltage supplied to the motor by adjusting the field on the generator. *Fig.* 26 shows typical regulation curves. With a shunt generator, the regulation of the motor at the different speeds is considerably greater than

Fig. 23—Schematic diagram of simplified control for use with motor on selenium power pack



if a compound generator is used. A compound generator can be so designed that the series field will supply field excitation causing the regulation at any desired speed to be flat, drooping, or increasing with load, whichever is necessary.

If the set is designed to give flat regulation at low speed, the regulation at higher speed will be drooping but, if the design is such as to give a flat regulation at top speed, low speed regulation will increase with the load. Usually the generator is designed to give flat regulation at slow speed.

This drive is usually good for 10 to 1 speed range and constant-torque applications. Slower speeds can be obtained for inching or machine adjustments but this results in poor regulation on standard drives.

Speed range may be increased to 40 to 1 by using a 4 to 1 motor with the standard adjustable-voltage generator. A typical speed range would be 60 to 600 rpm by variable voltage and 600 to 2400 rpm by field weakening. This drive would be good for constant torque over the variable-voltage range and constant horsepower over the range obtained by field weakening.

In special cases, a range of 80 to 1 may be had by using the 8 to 1 adjustable-speed motor with the standard adjustable-voltage generator. A typical drive might be 45 to 450 rpm by adjustable voltage and 450 to 3600 rpm by field control. The drive would be rated constant torque from 45 to 450 rpm and constant horsepower from 450 to 3600 rpm.

The second and less common of the adjustable-voltage drives is the self-excited shunt adjustable-voltage drive. In this drive, the exciter is eliminated and the generator is a self-excited, shunt generator. The shunt motor is also excited from the same source of power as its armature, *Fig.* 27.

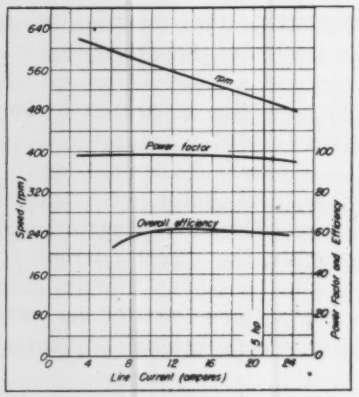
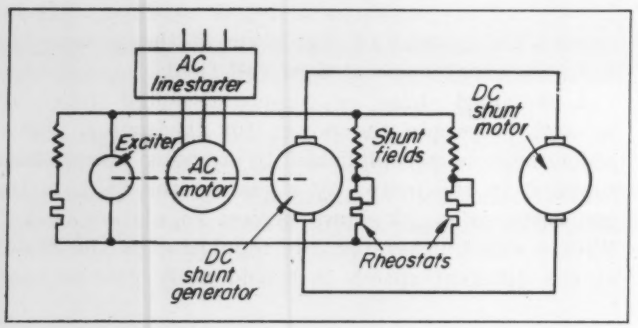


Fig. 24—Left—Overall performance of a 5-hp adjustable-speed motor powered from a selenium cell power pack

Fig. 25 — Below — Diagram of the conventional adjustable-voltage drive



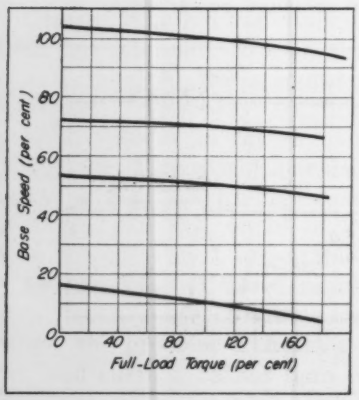


Fig. 26 — Left — Typical regulation curves of a 10 to 1 adjustable-voltage drive

Fig. 27 — Right — Circuit diagram of self-excited adjustable - voltage drive provided with dynamic braking and full-field starting

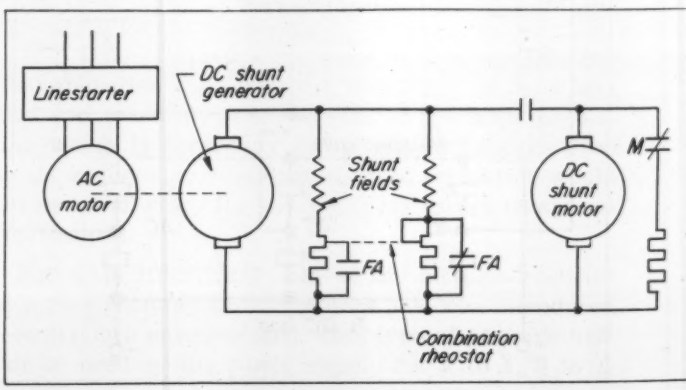
Generator Remains Stable

Any standard generator, when operated at a voltage below 60 per cent of rated voltage, tends to become unstable and lose its voltage, but with a specially designed field pole, this same generator can remain stable down to approximately 25 per cent of rated voltage.

Since a self-excited generator does not build up voltage quickly, the motor-generator set can be left running and the motor disconnected from the generator by a main line contactor. A field relay is used to insure that the motor is always at full field when the line contactor is opened.

Speed control is obtained by the use of two rheostats, one in each shunt-field circuit, mechanically connected together. The motor has a low-voltage field which is connected in series with one of the rheostats. The other rheostat is in series with the generator shunt field. When the generator is at weak field, rheostat all in, the motor is at full field, rheostat all out. When the speed of the motor is increased by raising the generator voltage, thus strengthening the generator field, the motor field is held constant by adding the correct amount of resistance. This is accomplished by having the rheostats operate so that, when one cuts resistance in, the other cuts it out, thus keeping the correct balance of current in the two shunt fields.

This type of drive can give a speed regulation of 4 to 1 by adjustable voltage. By using a 3 or 4 to 1 adjustable-speed motor with this generator and a special rheostat which will hold the generator at full



field and weaken the motor field in steps up to four times base speed, a range of 12 to 16 to 1 is available. Special drives using the 8 to 1 adjustable-speed motor can increase the range up to 24 to 32 to 1. *Fig.* 28 shows typical regulation curves of a self-excited adjustable-voltage drive. These are comparable with the separately-excited drive, except the speed range is not nearly as great.

This drive is rated like the separately excited drive: constant torque to base speed of motor and constant horsepower above base speed.

Both drives can be equipped with dynamic braking and can also be used for reversing service. The separately excited drive can be made to reverse by reversing the shunt-field excitation on the generator. Care must be taken that the motor is a shunt machine, or has a very weak series field, as its series field will be differential to the shunt field on reversing. On the self-excited drive, the reversing contactors must be in the main line, thus reversing the polarity of the motor; the shunt field cannot be reversed because the generator will lose its residual magnetism and then will not build up in either direction.

Self-excited adjustable-voltage drives are used for machine tool spindle drives and in other places where the range of speed desired is about 12 to 16 to 1 with a constant-torque load requirement to base speed and constant horsepower above base speed of 3 to 4 to 1.

Wide Speed Range Makes Drives Popular

Separately-excited adjustable-voltage drives are popular because of wide speed range. Typical applications include hoists, steel reversing mills, strip steel rolling mills, steel processing lines, sectional paper machine drives, textile and rubber conveying systems.

SERIES VARIABLE-VOLTAGE DRIVES: The series variable-voltage drive is a simple drive consisting of an a-c motor, series generator, series motor, line starter, stop and start button for the a-c motor, and a speed-adjusting rheostat. The series-motor speed curve at constant voltage is the inverse of a series generator voltage curve at constant speed. These characteristics are desirable in that the result of the two curves gives a resultant speed which is very flat, as shown in *Fig.* 29.

Speed variation shown in *Fig.* 30 is accomplished by the speed-adjusting rheostat *Fig.* 31, which shunts part of the load current from the generator series field, thus limiting the voltage applied to the motor. When the motor operates at light load, drawing a small amount of current through the series field of both the generator and the motor, the tendency of the series motor is to run fast. However, since a small amount of current through the generator series field means a low generator voltage, the motor tends to run at a set speed. As the load is increased on the motor, its characteristic speed tends to slow down but, with the increased current through the generator series field, the voltage applied to the motor is increased. The speed tends to remain nearly constant, providing the characteristic curves of the generator and motor are closely matched.

From *Fig.* 30 it may be noted that a rather flat speed regulation exists for slow speeds up to approximately 25 per cent load. For practical purposes, this regulation is good, since the friction load of the driven machine is usually as much as 25 per cent of rated load on the motor.

This drive is used for a speed range of 10 to 1 and can supply a starting torque of as much as 400 to 500 per cent of full-load torque at low speeds and much higher at high speeds. As is shown by the lower curve of *Fig.* 30, the drive can be used down to 20 to 1 and still have good starting torque. Advantage can be taken of this low-speed characteristic in threading or inching operations. This drive also

Fig. 28 — Speed regulation curves of the d-c self-excited adjustable-voltage drive

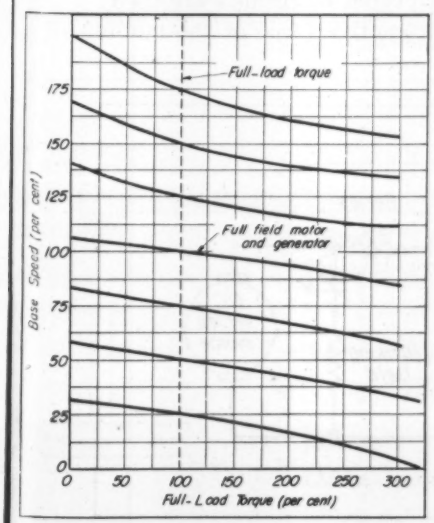


Fig. 29—Characteristics of series motor and series generator and the ideal resultant when the two are connected

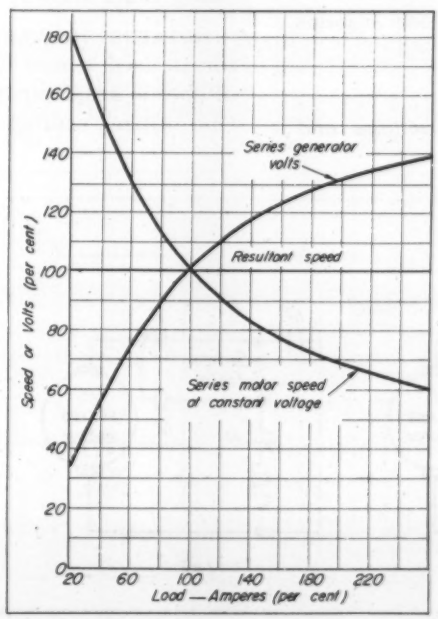
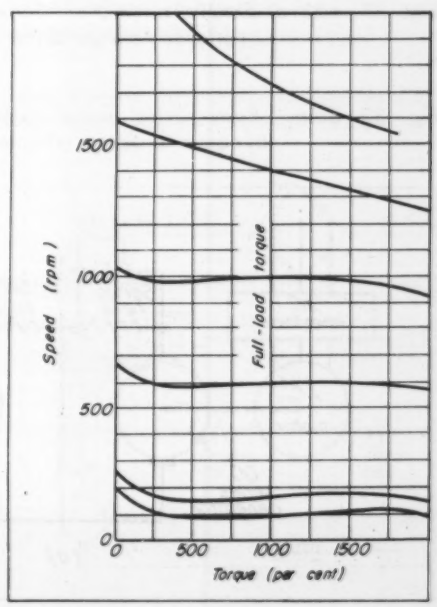


Fig. 30—Typical speed curves of the series variable-voltage drive



has little speed change due to change in temperature of the series field, whereas a shunt motor may change as much as 10 per cent.

Dynamic braking may be obtained, *Fig.* 32, by adding the necessary control for disconnecting the motor from the generator and reversing the motor series field, thus using the field for supplying the necessary load on the armature and, at the same time, supplying flux to the motor. This drive cannot be used for regenerative braking as the current would have to reverse, thus going through zero and killing the residual flux so that neither machine would build up.

The drive cannot be operated continuously at very slow speed, because of the lack of ventilation on the motor. For most applications, however, the machine is not run continuously at slow speed and its overall operation is satisfactory. Typical applications include: agers, dye jigs, dye cans, fans, padders, slashers, sanforizers, conveyors and washers.

SPECIAL SERIES VARIABLE-VOLTAGE DRIVES: A very special drive was developed to meet the need for flatter speed regulation without the complexity of a rotating type regulator. *Fig.* 33 shows the circuit diagram used to obtain the regulation curves shown in *Fig.* 34. The dotted curves are typical series variable-voltage regulation.

In effect, there are two electrical systems in operation, both of which include the motor and generator fields. Part of the excitation is supplied by the full wave rectifying system and the other by the load on the motor. As can be seen from the dotted curves for light load on the motor at all speed ranges, the motor runs too fast which means the motor field is too weak, whereas above full load, the speed of the motor is slow, indicating the generator voltage is too low.

Referring to *Fig.* 35, a typical current distribution can be seen at light load. The motor series field is operating at full load current, part of which comes from the generator and part from the separate source, thus lowering the speed at light load and flattening out the curve. With the motor operating at nearly full load current, the motor series field is still operating at full load current and the generator series field current is increased above the current drawn by the motor, thus increasing the speed of the motor above that shown on the dotted curves, *Fig.* 34, and tending to flatten out the speed curves. As can be noted from the curves, the speed is flattened out on both ends by this system of excitation.

With this type of excitation, an overhauling load (regenerated braking) can be applied and the regulation will remain flat, as seen in *Fig.* 34. *Fig.* 36 shows the typical current distribution for an overhauling load. It should be noted that the armature current has reversed, but the motor series field is still at full load current and in the same direction as before. The load current from the motor and generator circulating through the bridge rectifiers gives effective regenerative braking.

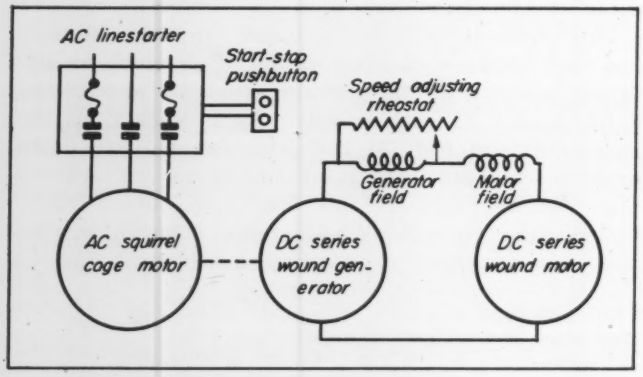


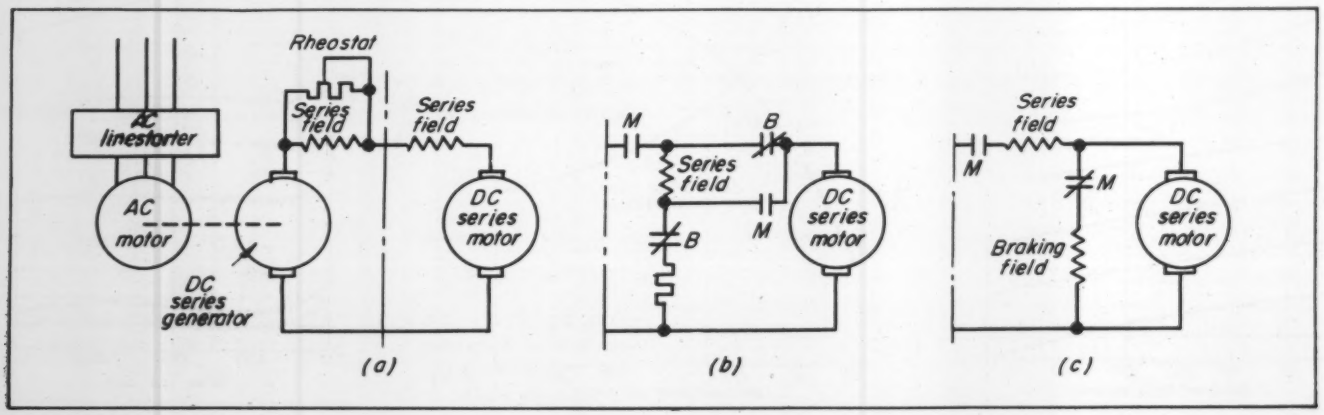
Fig. 31—Above—Simple connection diagram for a series variable-voltage drive

Fig. 32—Below—Basic series motor variable-voltage and dynamic braking schemes

Is Practical for Light Loads

This series variable-voltage drive has filled a great need where a simple, yet low cost adjustable-speed motor with a flat regulation is desired. It is practical in small horsepower ratings only because, where the rectifier would have to supply large amounts of power, the cost would be prohibitive. This drive is being used satisfactorily on the Landis tool centerless grinder shown in *Fig.* 1.

ROTATING REGULATORS: The rotating speed regulator is used where better accuracy and a wide range of speeds are desired. Two types of circuits are used: One utilizes counter electromotive force of the motor



Wichita City Librar.

and the other employs a pilot exciter to supply the proper intelligence to the regulator to hold constant speed.

A typical elementary circuit is shown in *Fig.* 37 for the counter electromotive force speed regulator. Speed adjustment is obtained by an adjustable rheostat in series with the generator and combined pattern and self energizing fields connected in a bridge circuit. Regulation at each speed setting is obtained by the combined effect of the regulator voltage field and the differentially connected current field.

In *Fig.* 38 is shown a speed-load characteristic obtained from actual tests on a 7½-hp drive using a counter electromotive force speed regulator. The range of regulation shown is 120 to 1, or 15 to 1800 rpm. The change in speed regulation at any speed is less than 5 per cent. There is no tendency to stall, even at slow speed and double full-load torque.

Advantages of this type of speed regulation are wide speed range with good regulation at all speeds as well as high running and high breakaway torques. Simplified mechanical equipment eliminates gear changers, clutches, or mechanical speed changers. This drive performs satisfactorily on machine tools, adjustable-voltage planer drives, high-speed elevator drives, skip hoist drives, winder drives and supercalender drives.

Holds Speed To Close Limits

Where it is desired to hold the speed of a motor within close limits, the pilot generator type of speed regulator is used. *Fig.* 39 shows a circuit of this type. A pilot generator supplies the regulator with the intelligence necessary to hold the speed of the motor constant. The approximate speed adjustment is obtained by rheostat control in the generator main field, motor field and regulator speed field. The regulator speed field provides a measure of motor speed which is compared with a set pattern as measured by the regulator pattern field. Any change in motor speed upsets the field balance and starts the corrective action, thus changing the generator voltage to correct the motor speed. The pilot generator

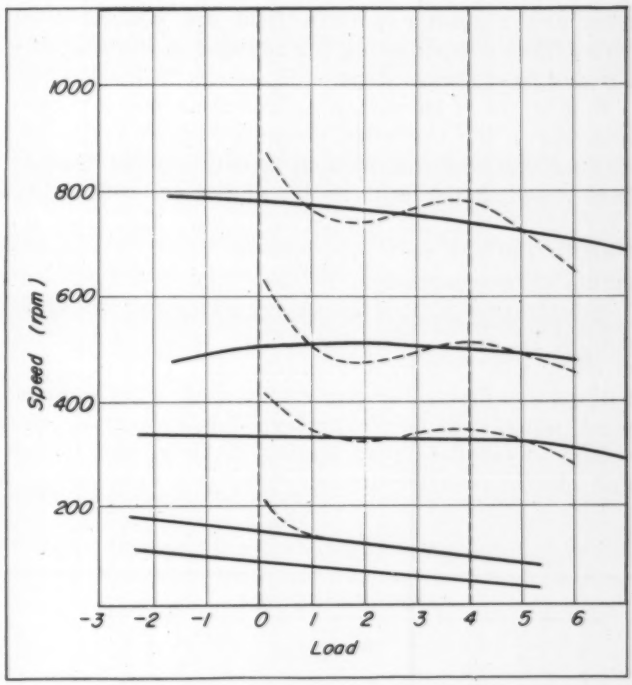


Fig. 34—Above—Speed-load curves of the series variable-voltage drive. Solid lines indicate regulation for special drive, dotted lines are for conventional drive

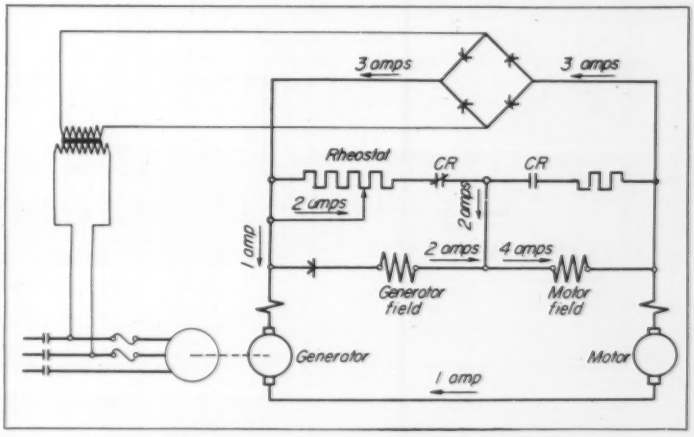
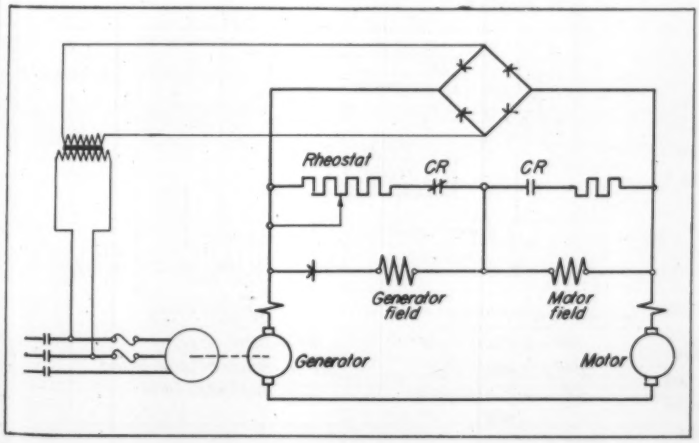
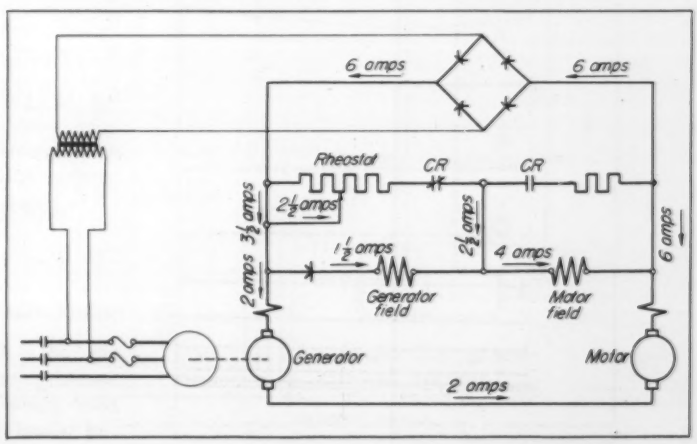


Fig. 35—Above—Typical current distribution for light load on special series variable-voltage drive

Fig. 36—Below—Typical current distribution for overhauling load on special series variable-voltage drive

Fig. 33—Elementary circuit of special series variable-voltage drive for regulating wheel of the Landis Tool centerless grinder illustrated in Fig. 1

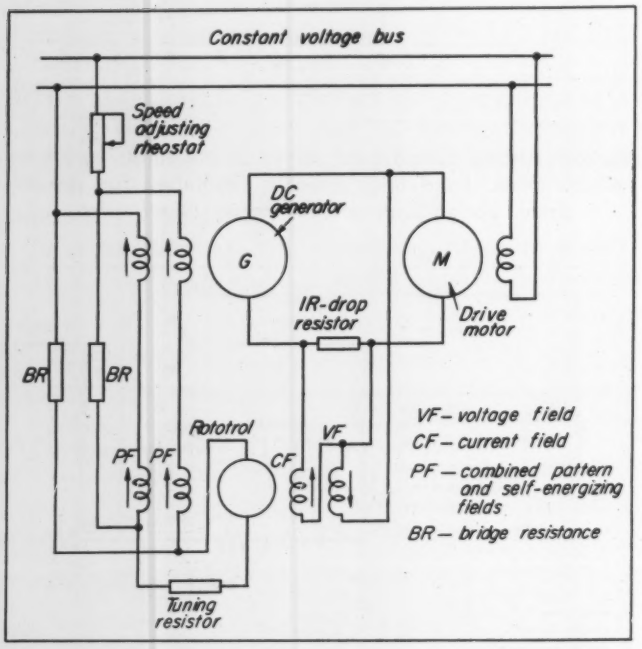




field and regulator pattern field are connected in series, thus compensating for changes in control voltage and field temperature.

In *Fig.* 40 is shown an approximate speed versus load curve for the pilot generator speed regulator. The accuracy of this method is within 1 per cent at base speed, 2 per cent at ½, and 4 per cent at ¼ base speed; and the regulation is very flat from no load to 100 per cent load because of the corrective action of the regulator.

Advantages of this speed regulator are accurate control of speed over the entire range, simplified circuits and minimum maintenance. Typical applications are drives for paper machines, wind tunnels, steel mills, textile machinery, dynamometers, machines to simulate road testing of tires, and rubber and plastic calender drives.



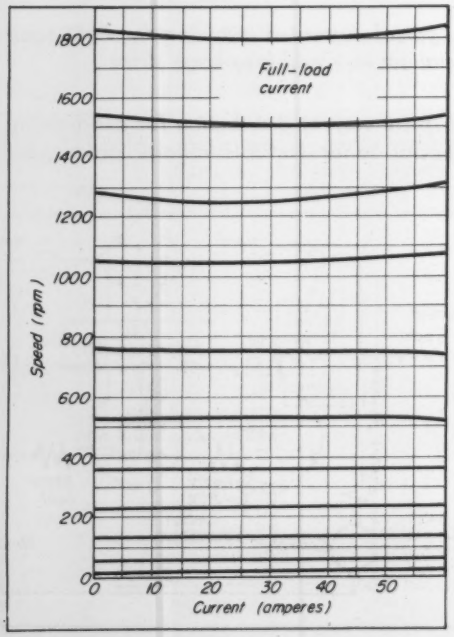


Fig. 37—Above—Elementary circuit of a counter electromotive force speed regulator

Fig. 38—Left—Speed-load characteristics on a counter electromotive force speed regulator

Fig. 39—Right—Elementary circuit of pilot generator type of speed regulator

Either the counter electromotive force or the pilot exciter method is well adapted to dynamic braking. Without any addition of control, the field excitation on the generator is removed when the motor is stopped, leaving the generator armature circuit closed and full field on the d-c motor. The generator armature acts as a load on the d-c motor which becomes a generator, thus giving good braking.

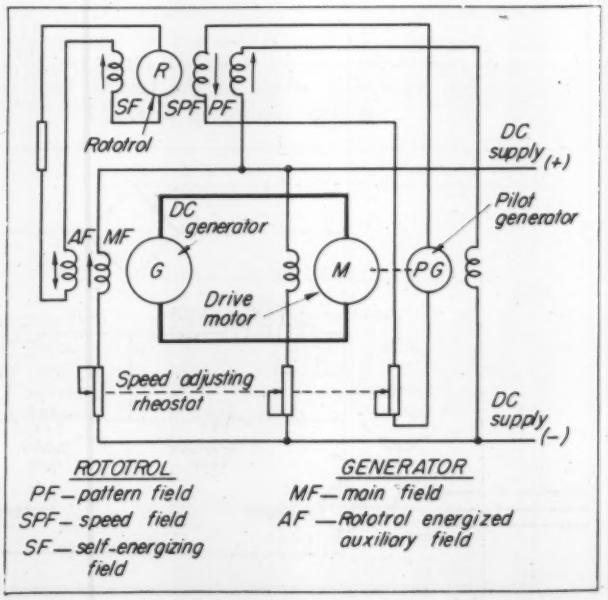
Has Effective Braking

Regenerative braking is accomplished nicely with this regulator. If the speed of the d-c motor tends to turn faster than the speed setting on the regulator, due to an overhauling load, it will pump power into the motor-generator set and thus back into the line, acting as an effective and efficient regenerative brake.

The rotating regulatory speed control must be rated as a constant-torque drive over the range of speed obtained by varying the voltage on the generator. If the higher speeds are obtained by weakening the field on the motor then, over this range, the drive can be operated as a constant-horsepower drive.

Temperature rating of the motor is at full-field rated voltage and speed. If operated below rated speed at a constant-torque load, the temperature will tend to rise and, at slow speeds, the motor will have to be operated intermittently, to maintain a safe temperature rise. For most applications, where slow speed operation is infrequent, the size of the motor does not have to be increased in order to run at these slow speeds.

ELECTRONIC CONTROL: The electronic adjustable-speed drive is an electronic rectifier and control system by means of which a standard d-c motor can be supplied with power from an a-c source, speed being varied accurately and smoothly over a wide range. *Fig.* 41 shows a simplified schematic diagram, using a Mot-O-Trol electronic control. In this drive, the cabinet and transformer take the place of the motor-generator set, and the small pushbutton con-



trol station takes the place of the larger control station and rheostat used with the conventional adjustable-speed drive. The normal speed range is 20 to 1 by armature control and 2 to 1 and up to 4 to 1 by field control, making an overall range of 80 to 1.

Speed of the motor is varied by a small potentiometer. The speed is automatically regulated so that, for a particular setting, it will not vary more than 10 per cent from any preset speed, as shown in *Fig.* 42 for a 20 to 1 range, and 6 per cent for a 10 to 1 range, as shown in *Fig.* 43.

Characteristics May Be Controlled

Also, with this drive the speed-torque characteristic can be controlled so that a flat, drooping or rising characteristic can be obtained for all the speeds within the operating range.

All speed adjustments, exclusive of field weakening, are accomplished by varying the motor armature voltage. This voltage is obtained by advancing or delaying the firing point of the rectifier tube on the alternating-current voltage wave, thus permitting only a certain portion of the alternating-current voltage wave to be rectified into unidirectional voltage and thereby controlling the speed of the d-c motor.

Regulation of the motor at a preset speed is controlled by the action of the grid control circuit which compensates for the effect of the armature *IR* drop caused by change in load. Since this is a measure, in effect, of motor electromotive force, the speed of the motor remains nearly constant. When the motor is started to a preset speed that calls for field weakening, starting always takes place at full field. The field is not weakened until the motor reaches approxiamtely base speed.

Dynamic braking is another feature which can be had with the electronic drive. The motor can be stopped quickly or slowly, depending upon the adjustment of the dynamic braking resistor. Automatic current-limit and time-delay acceleration is also provided. The starting current will never exceed the limit which is fixed by the setting of the current-limit control potentiometer. This limit can be adjusted to a value from 1.5 to 2.5 times rated armature current.

The motor can be reversed quickly without excessive current peak and can be brought to a speed in the reverse direction predetermined by the setting of the reverse-speed control potentiometer. Settings of the forward and reverse speed-control potentiometers can be different, so the motor may run at whatever speed is desired in each direction. The d-c motor used with this drive ordinarily requires a frame one size larger than if it were to be used on straight d-c voltage. The reason is that the a-c ripple due to rectification causes considerable heating in the motor armature.

Motor temperature decreases as the number of phases increases, with the greatest degree of heating occurring in the single-phase units. At extremely low speed with constant-torque load, the motor temperature rise will increase above the 40 C rise rating at base speed, but will stay within safe operating limits. The electronic control is a constant-torque

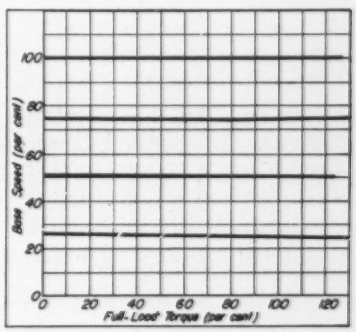
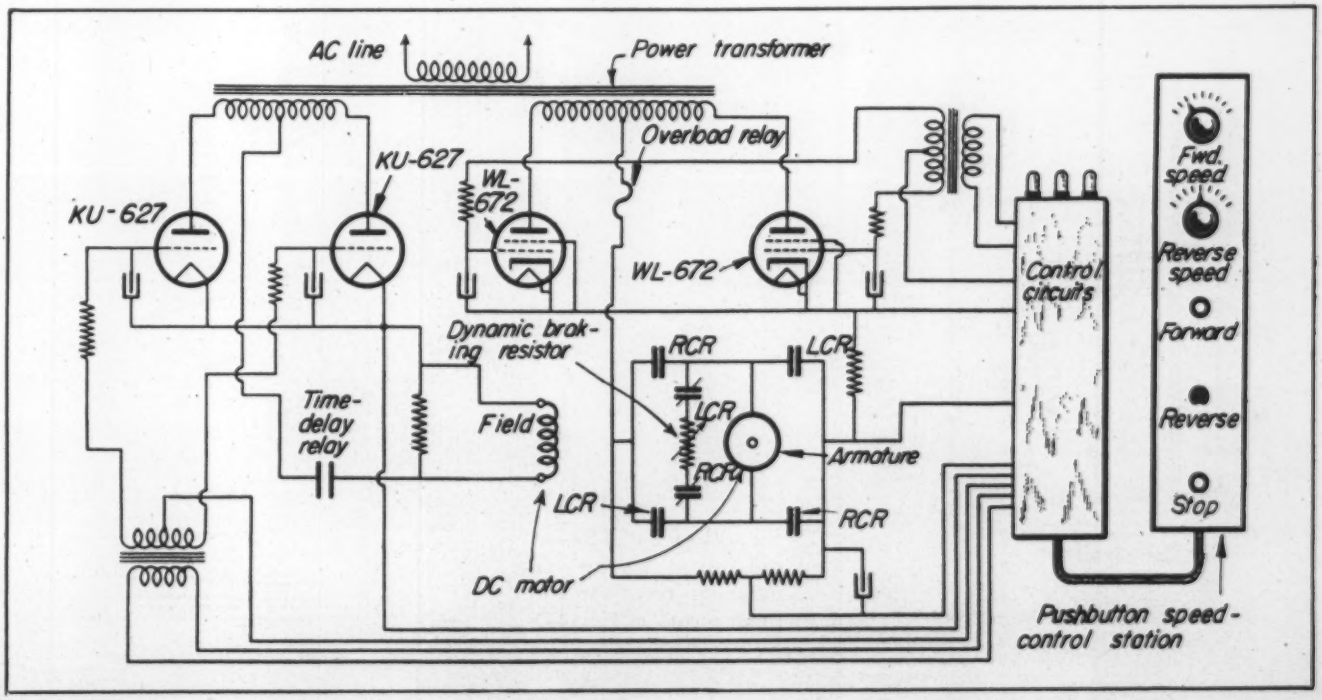


Fig. 40—Right—Typical speed regulation curves for pilot generator type speed regulator

Fig. 41 — Below — Schematic diagram of Mototrol electronic power circuit



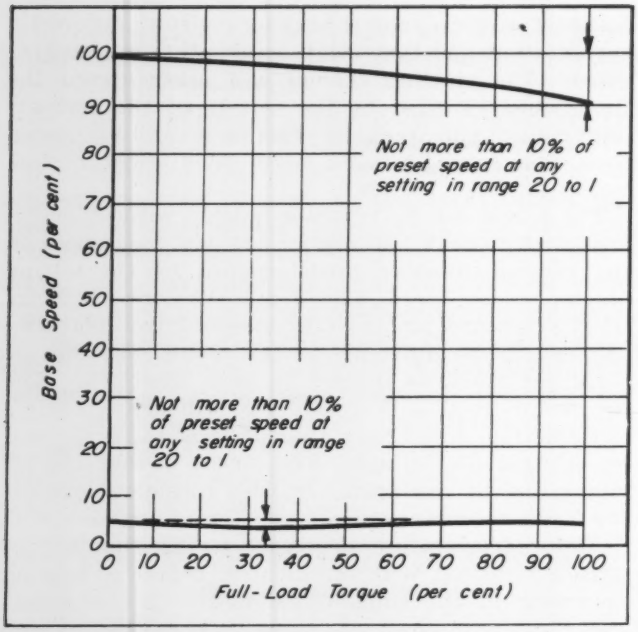


Fig. 42—Speed regulation curve of the 20 to 1 speed range Mototrol electronic drive

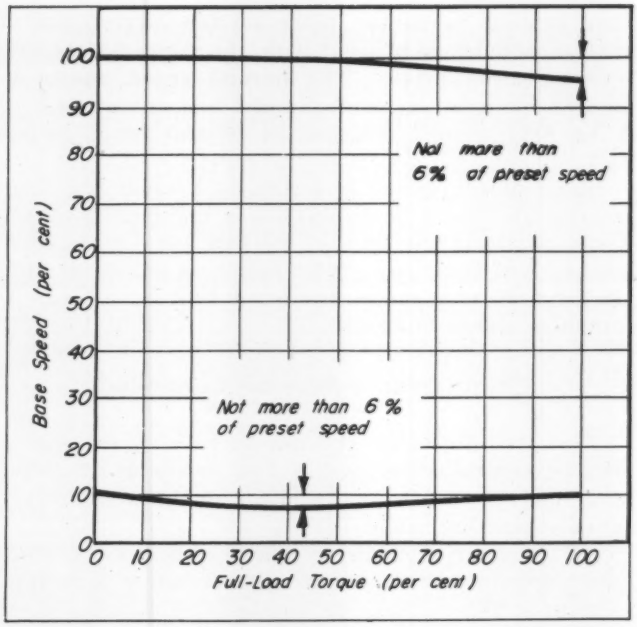


Fig. 43—Speed regulation curve of the 10 to 1 speed range Mototrol electronic drive

drive over the range of speed controlled by armature voltage, or base speed of motor, and a constant-horsepower over the range of speed where field weakening is used to control the speed.

Some of the more common applications are: conveyors, lathe drives, tool feeds on lathes, grinders, milling machines, slotters, gear cutting machines, wire shakers, rotary cutters, reels, bag machines and other drives which require constant-torque over a speed range where good regulation is required.

MAGNETIC AMPLIFIERS: A new comer as a source of power for variable-speed d-c motors has made its appearance in the use of magnetic amplifiers. The amplifier takes power from an alternating-current source and changes it into variable-voltage direct-current for d-c motors, by the use of a transformer, a saturable reactor and a rectifier. *Fig.* 44 shows a typical circuit diagram of the magnetic amplifier control.

The transformer is used to supply the proper a-c voltage from the a-c line. The saturable reactor, which is in series with the rectifier and the motor,

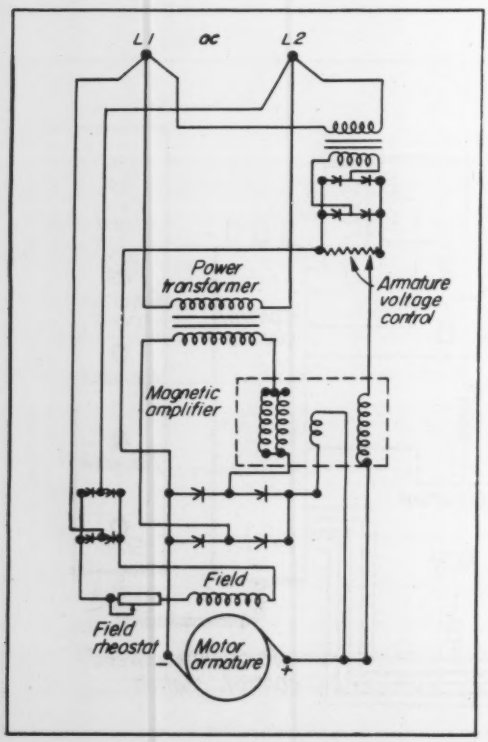


Fig. 44 — Left — Circuit diagram for a magnetic amplifier control for a ½-hp adjustable-speed motor drive

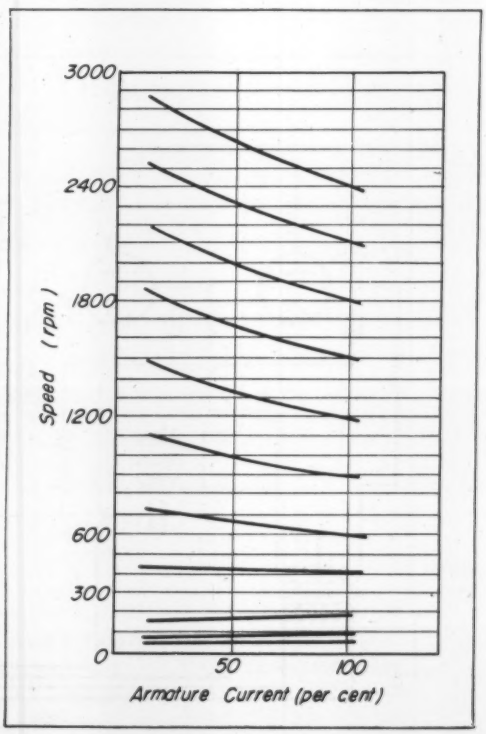


Fig. 45—Right — Speed regulation curves for magnetic amplifier system shown in Fig. 44

is used to vary the impedance of the external secondary circuit of the transformer, thus varying the voltage which will be applied through the rectifier to the motor armature. Impedance of the reactor is varied by the use of a d-c coil wound on one of the legs of the reactor. By adjusting the current in this coil, the impedance or voltage drop on the reactor may be changed, thus an adjustable voltage is supplied to the armature circuit of the motor after being rectified by the rectifier.

In *Fig.* 45 is shown a typical regulation curve for a 4 to 1 adjustable-speed motor using a magnetic amplifier. The total range is approximately 60 to 1 with 4 to 1 by field weakening, and 15 to 1 by adjustable voltage.

As the use of the magnetic amplifier becomes more common, many improvements will be made in the present circuit, and possibly many applications may be found in which it can be used in place of the rotating regulator and the electronic control.

TABLE I summarizes all that has been said about the nine basic systems for controlling the speed of a d-c motor. It sets forth the requirements of the driven machine—speed range and regulation, constant or varying load, reversing duty, braking, etc.—and thereby establishes the primacy of these when selecting a drive.

In addition, it is a record of the progress that has been made during the past generation in machines and their drives. For, as the former have increased in complexity so have the latter. It is also a barometer of what the future holds insofar as drive requirements might be related to the pushbutton plant of tomorrow. For, as we have progressed from the simple to the complex as we know it today—from the armature resistance method of adjusting the speed of a d-c motor to the magnetic amplifier system of controlling speed—it is only reasonable to conclude that tomorrow's machines will demand even further refinements in drives.

Just what these will be cannot be accurately predicted but certainly two developments can be expected. First of all, a refinement and simplification of presently known systems and, secondly, systems that go beyond the limits of speed range and regulation as they are known today.

Oxygen Converter Conserves Space

NEW oxygen converter system that uses the liquid form of oxygen instead of the gaseous type is being tested at Wright-Patterson Air Force Base by the Air Materiel Command's Aero-Medical Laboratory. This new system will mean increased safety for fliers, as well as a saving of space and weight required for the necessary oxygen breathing systems in the planes.

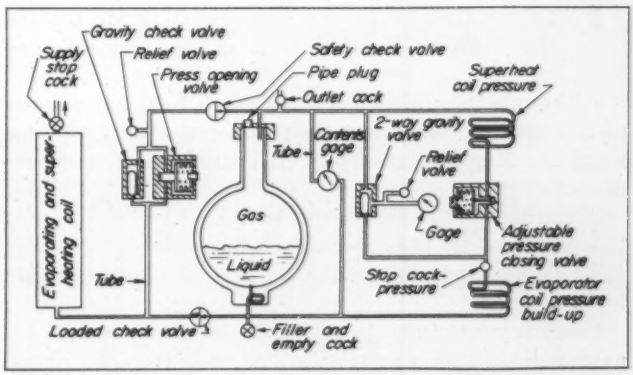
For use at remote bases where the oxygen manufacturing equipment would not be practical, storage tanks are being designed that will hold as much as 1700 gallons of the liquid. Transports of the C-74 variety will carry one of these tanks. To transport an equal amount of oxygen in the gaseous form would take four and one-half times as much space, besides about an 80 per cent increase in weight due to the number of containers that would be required.

Testing of the new converter supply system is being made in B-17's. The gaseous type of oxygen supply units for the B-17 weigh slightly over 400 pounds when fully charged, while the new type weighs 130 pounds. There is also an 80 per cent saving in space.

With all this saving of weight and space, the volume of oxygen available for human consumption is increased by 44 per cent. This is possible because when changing from a liquid to a gas, the relative volumes are in a ratio of 1 to 800, which means that 1 cubic foot of liquid oxygen will provide approximately 800 cubic feet of gaseous oxygen upon vaporization. This is the principle upon which the converter operates.

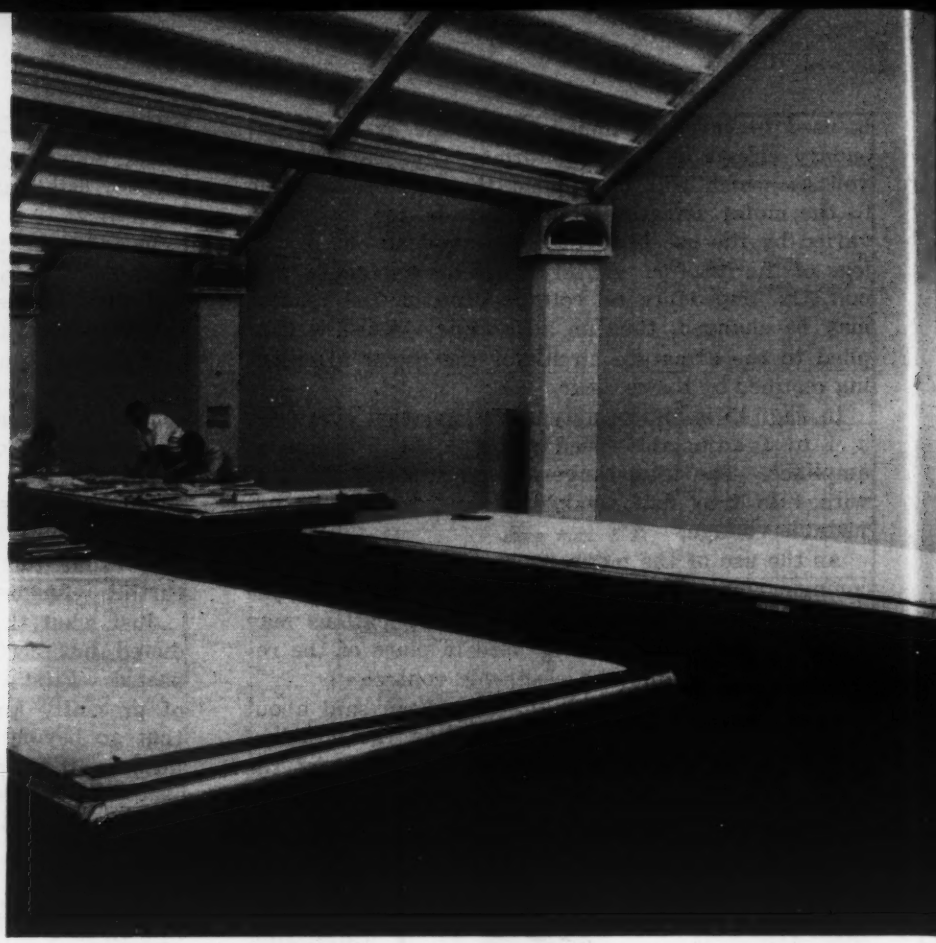
The converter consists of a metal container for the liquid oxygen with a vaporizing coil and the necessary safety valves and specially designed operating valves. The liquid, upon vaporization, is forced through the oxygen system due to the pressure formed by the change from a liquid to a gas.

Insulation for the small units installed on planes was solved by applying the laboratory method of preserving the necessarily low temperature of −297 F, that of vacuum-walled containers. Tests show that the amount of liquid oxygen needed for



a B-17 crew would be little less than a cubic foot per flight, and this amount can be handled in a vacuum type container.

The excessively low temperature of liquid oxygen with its boiling point of −297 F presents little difficulty if the storage unit is punctured. Evaporation is so rapid that, even if some of it is splashed on the skin, none of the liquid actually touches the skin. The liquid immediately vaporizes, causing the formation of an insulating layer of gaseous oxygen between the skin and the liquid and thus preventing freezing.



By Clarence L. Pfeiffer
Body Engineering Staff
Briggs Mfg. Co.

A More Effective Drafting Room

TO the veterans of the drawing board it is apparent that there is a different attitude toward the work to be done than existed prior to the war.

Although the union has done much to bring a sense of security on the job, it has fostered a tendency toward indifference, resulting in decreased accomplishment.

An antidote for this attitude must be developed by the policies of the company, and this article discusses some aspects of what an effective policy should include.

Company attitude is reflected by the general appearance of the drafting room and the equipment provided, giving due regard to the financial ability of the company to provide a good workshop. Lack of interest on the part of management is conducive to a lax attitude in the men. Material and psychological elements are necessary to effective construction of a productive drafting room. Some items might at first appear trivial, but closer study reveals the important part they contribute to the desired result.

A safe parking place for those who drive is not, in a sense, optional, for if the men are required to spend several minutes every morning in an attempt to park their cars, they arrive at work with disgruntled attitudes. If from the parking spot they go to a dirty washroom before beginning their day, further irritation results.

ATMOSPHERE: Primarily important is the drafting room where the great portion of the day is spent. The atmosphere here will either provide incentive, create indifference, or repel the worker. Cleanliness will be noted first, especially windows and walls. Even though extremely well-kept, a drafting room will have a dingy appearance if illumination is poor. Usually daylight is the predominating source of light, but if it enters from only one side of the room, harmful shadow effects on the boards will become greater with increasing distances from the windows. Chances are fair that artificial light is required even on bright days. If such is the case, the source must be so located and of sufficient strength to dispel the shadows created by natural light. The ultimate should be to have the light inside as evenly distributed as outside. Artificial lights must not, however, generate so much heat as to make the place unbearable on warmer days. Where draftsmen are permitted to smoke, a system should be provided to remove the smoke quickly enough to satisfy the demand for clear air. These several features of an effective drafting room have been incorporated in the design illustrated in *Fig.* 1.

EQUIPMENT in the drafting room is the greatest mirror of attitude. Detailing tables are almost

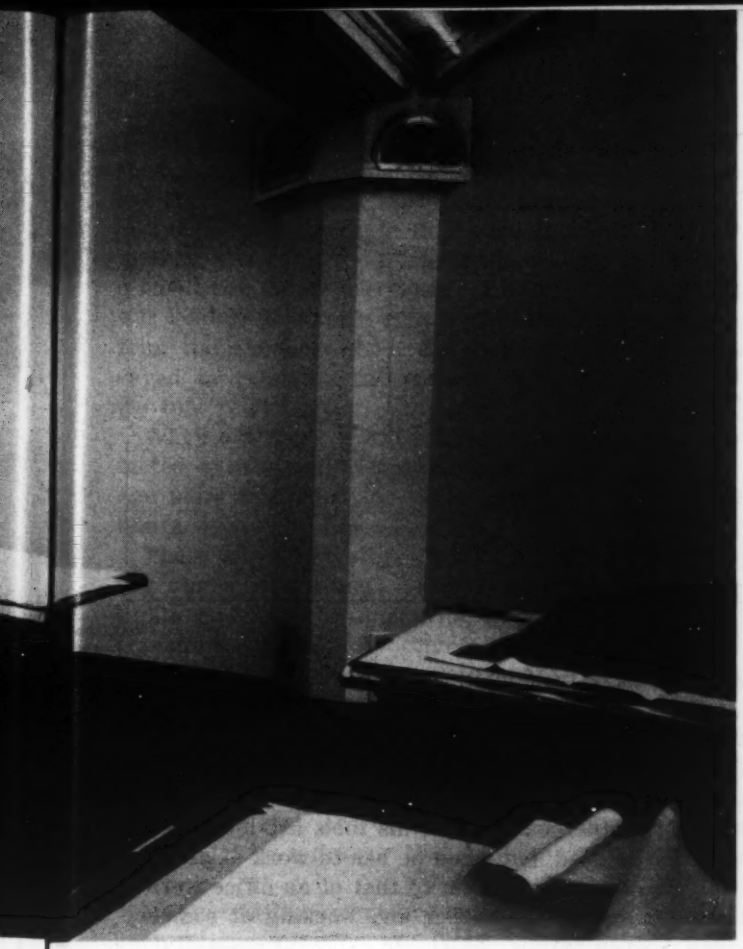


Fig. 1—Designed specifically as a drafting room, this building obtains natural light from the north and fluorescent light on the shadow side to give excellent distribution of illumination. The room is cooled in the summer and warmed in the winter with a uniform humidity, thus insuring less shrinkage and stretching of paper or cloth than is possible in natural air. Vents provide for the exhaust of smoke and the demand for clear air. Table design providing adequate storage and accessibility can also be noted. Photograph through courtesy of Briggs Mfg. Company

A draftsman takes a hard look at conditions prevailing in many design offices. In this article he offers constructive criticisms and suggestions for improvement leading to higher productivity

standardized, having a lockable drawer for tools and a wide, shallow one for drawings. Larger or full-sized boards are frequently made in the company's shop. Rough working surfaces and generally poor carpentery are accepted as evidence of company disinterest in layout and design results. Boards mounted on sawhorses that will shake whenever one makes an erasure should be known as "one man" boards, it being practically impossible for more than one man at a time to work on this type of structure. Every movement that a worker makes is directly disturbing to everyone else on that board. Height should be such that one can sit comfortably for detailing parts on the layout; edges should be protected so that the possibility of tearing clothes or gathering slivers is eliminated.

There are certain small hand tools used by the draftsman which by nature of size and value have always been privately owned and will probably continue to be. Responsibility for their care is thus

Fig. 2—Specially designed racks to store full-size aluminum drawing plates are used in body design work. As many as 450 plates, each 6 ft by 22 ft, can be stored ready for use on this rack at one time. In addition, body engineers can pull out a plate and take off the desired detail while the plate still hangs on the rack. Photograph through courtesy of Ford Motor Company

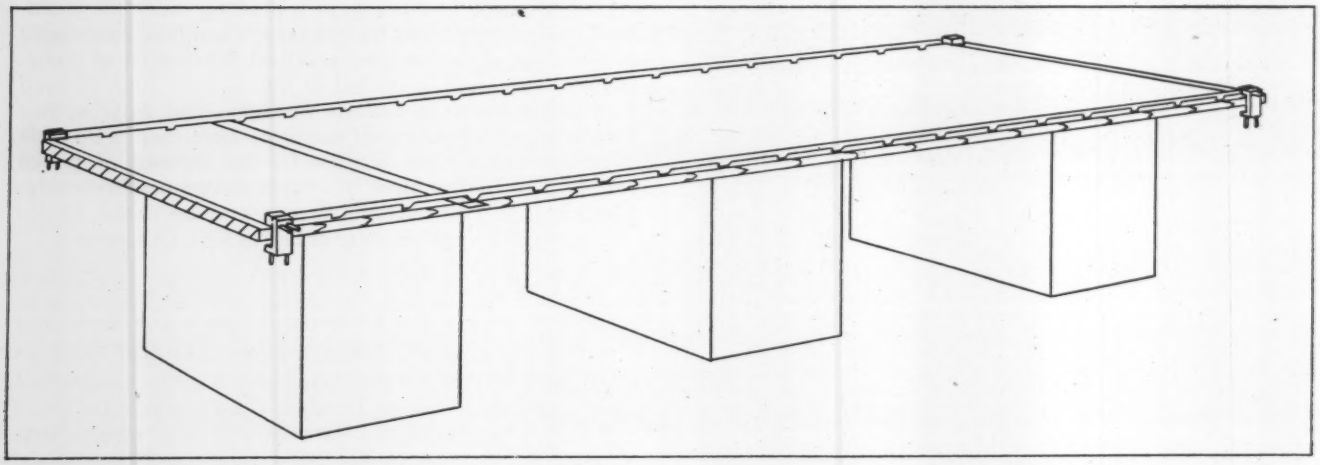


Fig. 3—This liner, as it is called, is set up for drawing lines the width of the board. In setting up the liner, a straight edge is held coincident with the established line and the squared edge of the stop placed against it. In this position the bars are securely clamped at both ends to the posts by the two upper screws. Straight edge may now be moved and the new parallel lines may be drawn or scribed at any of the stopped positions desired. For drawing horizontal lines the stop bars are placed across the board and adjusted to the established line in the same manner. For a drawing table of the proportions shown, two sets of stop bars and two lengths of straight edges would be required to obtain adequate flexibility

automatically fixed. A draftsman's hand tools are just as surely labor-saving devices for him as are the factory's machine tools for the mechanic. The longer a draftsman has pursued his business, the more of these hand tools he will have acquired, and any draftsman who has the incentive to get work out will want to make use of all tools that can help him. If there is no lockable place for a draftsman to keep these tools, and he feels that there is any possibility of anyone stealing his tools while he is away, overnight or weekends, he will bring in only as few as he can get by with.

It goes without saying that location of the lockable drawer or cabinet for convenience and accessibility is an important factor in maintaining efficiency. In most fields of drafting, the work can generally be brought to the draftsman's board or table. The detailer, for instance, with a drawer under his board can organize his tools therein so that they are instantly accessible, keeping on top those which are used constantly. Large sweeps and other tools that are used momentarily are put away again so that the working surface is not cluttered.

This is an ideal situation, but the layout man working on a large table is seldom alone at the board where his tools are located. There are usually several men working at the board; sometimes, with poorly planned work, as many men as can be crowded together. Needless to say, the tools on top should be kept at a minimum per person. In the ordinary case of three or four men to the board, a man may be working at the opposite end from where the drawers containing his tools are located. If someone else is working in front of this set of drawers, that person will also have to be disturbed when access is desired. One way to reduce this disturbance factor is to build the drawer long and narrow so that it extends under the table from one side to the other, thus being accessible from either side. As long as a draftsman is working at the board where his tools are located, the situation is good, but when he has to work at another board the situation is akin to that of an office worker having a desk in one office and working at someone else's desk in another office. In some offices a draftsman is obliged to work a hundred feet or more from where he keeps his tools. This requires that he pick the tools he thinks he may need at the beginning of the day or job. If he takes all of his tools, the working area inevitably becomes cluttered; if he takes but a few, frequent trips result in lost time. It stands to reason that greater efficiency could be attained if the man and his tools could be kept closer together, and, with some forethought, there could be many more cases where the work could be brought to the man.

Thought vs Brawn and Injury

Drafting boards should be arranged with sufficient aisle space so that persons may walk between the boards without having to disturb others at work, a five foot aisle being none too wide. Related drafts should be adjacent with a place nearby for old drafts for reference. Master layouts are sometimes made on sheet metal and are large and bulky. If they are stacked one on top of another on a table, against the wall, or in a rack, the use of four strong arms and a lot of time and inconvenience are required before one can find the draft desired. An effective scheme has been to hang every sheet on hooks mounted in rollers on a track, all tracks being twice the length of the longest draft, *Fig.* 2. Thus, from the stack, the desired draft may be rolled out quickly, easily and completely.

Where metal plates are used extensively, much can be done to prevent injury both to the person and his clothes from the square cut corner of the sheet. In one company accidents of this type occurred frequently until the draftsmen out of self protection snipped off the sharp corners and filed them smooth.

Today draftsmen do not have metal-working tools so that a metal worker must be called from the shop for that purpose and this cannot always be conveniently timed. Finally, in this same company, a better method was devised. A special tool about the size of a small bolt cutter was made. Designed to fit against the 90-degree corner of a sheet, two cutting edges trim the sheet to about a 2-inch radius. The time saved in rounding the corners more than paid for the tool every year.

When not being worked on, drafts can best be protected by a waterproof dust cover. Convenient storage place is needed for these covers during working hours.

There are a few other furniture items some drafting rooms still forget; one is a glass top table with lights under it for comparing prints or tracings by transmitted light. Another is a storage cabinet in which rolls of vellum or cloth can be kept without spoilage due to dust or unrolling, and arranged so that a piece of desired length can be taken without fussing with scissors and knives or folding and tearing from a straight edge. This cabinet should hold the printed standard detailing sheets, also duly protected and in a drawer that can be closed with one hand.

Many drafting rooms are improperly equipped with such relatively inexpensive items as pencil sharpeners. Both types of pencil sharpener should be available, the usual type cutting the lead to a point, and the draftsman type allowing the lead to stand for chisel pointing. Common sense will help to locate these sharpeners so that the long walk will be eliminated.

Frugality vs Waste

Employee use of equipment will be influenced by the manner in which it is kept. Frugality in the way of stationery supplies is not liked, but careless waste may be avoided. Small items such as pencils, erasers, etc., may be dispensed by a clerk, who might have other duties, rather than being left for indiscriminate use.

LARGE LAYOUTS: A few decades ago when designing of large parts full size was done on paper, to lessen errors due to the shrinkage of the paper a practice was developed for ruling the sheet with lines 10 inches apart, usually with red ink so as to be distinct from the drawing. Scaling could then be done to the nearest 10-inch line. Today the designing of automobile and bus bodies, airplanes, railroad cars, etc., is done on a metal plate, usually aluminum, to eliminate errors of shrinkage, yet the use of 10-inch lines has been established as an indispensable working convenience both in designing as well as taking off.

To get these 10-inch lines on the worksheet correctly is worth considerable effort so as to facilitate later work. First requirement is a straight and accurate base line. With the paper drawings, wood straight edges were satisfactory and were obtainable or made the length of the board. But today, with the greater accuracy obtainable on the metal plate, a steel straight edge is deemed necessary. Many drafting rooms making layouts 15 feet and longer use a steel straight edge 6 or 8 feet long to establish these important full-length base lines. After years of trying to get a perfect line by stretching a thread or wire, or overlapping two or three straight edges, draftsmen have quit complaining and do the best they can, but the need of a long straight edge still exists. Why not make this, and a proper place for its storage, a requirement for a well-equipped drafting room?

10-Inch Lines Easily & Accurately

After establishing a good straight base line, a perpendicular must be erected to it. The method of Pythagoras has not yet been improved upon! The rest of the 10-inch working lines are merely parallel to these two at 5 or 10-inch spaces. This, however, is not easy and takes time to complete. With little exception, this method of ruling a sheet with 10-inch lines is still used. One recent development is the photographic reproduction of the 10-inch lines onto the sheet desired. But even this requires an accurate original and when the lines are scribed on the reproduction, inaccuracy creeps in. One of the most outstanding developments in this line is the contribution of a craftsman in a Detroit plant. It consists essentially of a pair of bars having stops 5 or 10 inches apart, and a means of holding these bars so that when one of these perpendiculars is properly established, any number of lines may be drawn parallel to it, *Figs.* 3 and 4. Even this splendid idea has never been carried to its fullest possibility, and the draftsmen using it have to put their 10-inch lines on in 6-foot units.

Large drafts are used when the part shape involves curves. The most convenient way to get long curves is by use of a template or sweep made to the arc of a circle. A frequent practice has been to make the opposite edges of these curves successive values of arcs or radii. No drafting room has been built in which the light is not stronger from one side than the other. Therefore, one is bound to work half of the time on the shadow side of the sweep. This could be avoided by making the sweeps with both edges the same. Then, regardless of how the draft is oriented to the light, one can always use the side that does not cast a shadow.

If the engineering department employs more than a dozen layout men, there should be more than one set of sweeps so as to make immediately available the sweep one wants. Flat sweeps, having a radius of over 150 inches, are more frequently needed long, say, 5 or 6 feet, while those of greater curvature, under 150 inches, are more conveniently 2½ or 3 feet in length so that they can be used with less interference to others on the draft.

In any drafting room there must of necessity be a subdivision of work, but to accomplish this requires a repetition of certain information. The end point of one draft may be the starting point for another. It is vitally important that these lines be exactly the same on every draft where they appear. Most drafting rooms follow the procedure of transcribing the line point for point with the points spaced as closely

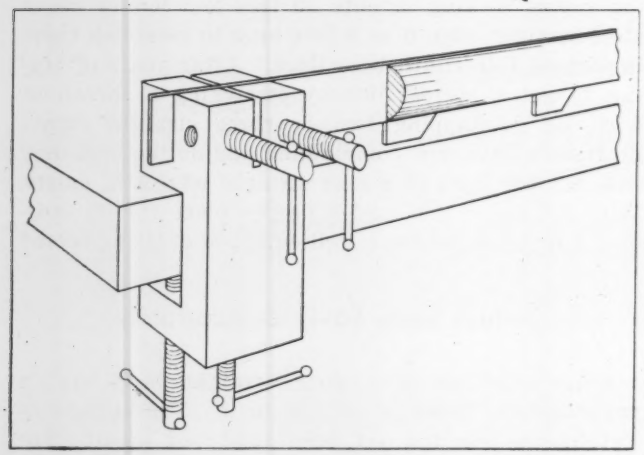


Fig. 4—Construction of one of the corner posts of the liner shown in Fig. 3

as the draftsman feels it necessary to fit the curves or sweeps available. Hours and days may be consumed in this process of duplicating lines and yet the result not be perfect.

One company has achieved the most practical solution to this problem by having pattern-makers make a template to all these important lines. In so doing, it is possible to iron out small irregularities, and the line, when finished, is actually better than that made by a draftsman using a number of sweeps. The template thus made may serve 20 or 30 times in the drafting room, and then serve further in the process of manufacture. Some "lines" were used so often that the template was duplicated and triplicated. The line thus "finished" can be inscribed as a whole on any other plate by the use of three or four checking points in the space of minutes instead of hours. If a draft is inked for permanent record this template will expedite the work. As compared to a photographic reproduction, the "line" can be placed just where it is wanted and need not lose its sharpness.

ADMINISTRATION: In the preceding discussion, it has been implied that the sincerity of the company in providing good equipment has a great influence on the efficiency of the drafting room. There are other important factors to be considered.

First in importance are the qualifications and character of the superior. Subordinates are sensitive to their superior's ability to handle work, hence the department head must be well grounded in the work he has to direct. If his selection for the job has been based on reasons other than merit, the incentive created by good drafting room equipment can largely be lost.

Good leadership fosters independent thinking and should permit maximum freedom of action by subordinates in areas where they are qualified to exercise judgment.

Importance of fair distribution of work may seem too obvious to mention but failure to pay proper attention to this phase can wreck morale. For example, suppose there is an irksome job to be done. The boss may not wish to risk asking the man if he would enjoy the job, but the man could be made to feel that he was selected for the job because of certain qualifications, abilities, adaptation, or some other good and sincere reason which might be no more than his dependability.

Administration of "rush" jobs is another vital consideration. A draftsman is taken off a regular job for the purpose of rushing information to the shop. The information is presented and the man goes to work with vigor. Details are made, numbers assigned, and the men begin to feel that they have done well. To their dismay, the design is not accepted by the boss. What is wanted? Sketches are made of several ideas to crystallize the suggestion of the boss and submitted for approval or comment. After waiting a day, the men make inquiry as to what the boss wants done. The answer is that it has been inconvenient for him to review the results as yet. When a decison is finally reached and brought back to the drafting room, layout men and detailers cannot be expected to work with the same vigor as at first. The effect of this procedure on the attitude of the men toward the next rush job can be little short of disastrous. Obviously, the cure for this is for those in authority to know what they want before they ask for that special effort.

Work must be well organized for slovenly direction results in slovenly output. Men, even those who might appear slow-moving, are sensitive to organization. The manner in which their work is planned and distributed tends to organize their mental faculties. Degrees of willingness, alertness and quality are directly proportional to the planning of department heads. Scheduling of work should be such that the draftsman knows there is further work for him at the completion of his present layout. Fear of nothing to do or the possibility of being transferred to something he does not care for leads him to slow down.

Overtime—Blessing or Burden

Contrarily, a situation arises in which it appears that there is more work than can be handled by the men. This condition is created by the boss or the executives through having men work weeks and months on jobs that are relegated to the wastebasket. This may develop from the desire to put into production ideas that are only in the experimental stages. Certainly experimental work should be done, and more than is done now, but not when the job is assumed to be ready for production.

After a company has filled all available space for drafting or is unable to get more men, or the boss feels that the work cannot be subdivided further, a program of overtime is introduced. In spite of the fact that the need for overtime is never explained to the men, it is usually met by a cooperative response, for a week or two, or until some of the work done on overtime has to be thrown away. Within a period of three or four weeks, depending on how heavy the program is, the overtime becomes very monotonous and the tempo of work goes down throughout the day.

The result is the same now when overtime is paid for at time and a half as it was prior to the war when the company was able to impose free overtime on its engineering staff under penalty of losing their

positions. Today there is never expressed any opposition to overtime; men stay for the bonus. With the confining physical condition imposed on a man in engineering work, the need for revitalization makes it necessary to get out into the fresh air for exercise. Surely the struggle of the last decade to gain an 8-hour day should not be thrown away. When overtime is continued indefinitely, several questions may be asked. Is the 40-hour week wage paid the draftsman inadequate so that he requires that extra overtime to meet his normal living expenses? Does the company pay this overtime to keep the draftsman from going to another company at a higher rate of pay? Is the company paying this overtime to prevent having to raise the base rate so that upon the first decline of company earnings it may effect an economy by cutting out the overtime? Perhaps the company is a job shop, with an agreement on overtime. Whatever the answer may be, it is certainly evident that the company does not regard too highly the cost of engineering. That this is the conclusion carried in the minds of the staff is evidenced by its efficiency of operation when overtime becomes a steady diet.

Drafting rooms in which the best working conditions exist could do in 7 hours what is presently accomplished in 9 or more hours.

Pettiness Invites Abuse

An endless succession of petty rules and regulations invites abuse. Most men want to do their work as quickly as possible. They prefer to take the direct route from their place of work to where they can get the information needed, but some regulations call for round-a-bout, time-consuming traffic restrictions where no safety or privacy requirements are evident. Of course, there are times when rules and regulations should be made to assure fair treatment to all employees. For instance, in the matter of the use of the phone, some greatly abuse the privilege. There is no economy, however, in forbidding all personal use of the phone or in imposing the use of a single phone booth for a large number of employees, necessitating a man's waiting his turn or coming back three or four times. Anyone with the responsibility of home and family may require to make a call occasionally during business hours.

Patent protection, unblanketed by legal twist, is necessary if men are to create. Contributions toward development will not be made if the reward motive is smothered. Executives and minor superiors should realize that a drafting room can become sterile if the incentive to apply training is removed.

Finally, in order to assure a fair, impartial treatment to all, promotion or increase in pay should be made a matter of published company policy, or included in a contract.

Here are some suggestions which should help maintain steady work:

Pay basis—40-hour week or less

Pay increases:

a. To everybody on the payroll, at a fixed date or upon the anniversary of their hiring, an annual increase of 6 per cent, or a semi-annual of 2½ per cent, unless there has been a general increase greater than this amount, and then the company may skip this date until such time that the accumulated increases become greater than the last increase granted, whereupon the difference becomes due the next period

b. The company may exceed this rate at its own discretion

Vacation allowance:

a. One work day with pay for each calendar month employed after the first full calendar month, up to one year

b. For every month that an employee has perfect attendance, neither tardy nor absent, whether excused or vacationing but exclusive of company shutdown, an additional one-half day vacation allowance

c. Upon completion of the first year's service one additional day vacation allowance for each year's service

d. Vacation may be accumulated for two years, or taken in whole or part at one time in any of the seasons of the year upon mutual agreement of employer and employee, but not to be withheld for more than one year by the employer

Sick leave—none

Separation notice and allowance:

a. First two months of any employment probationary

b. One day's pay separation allowance for each month worked

c. If employee quits the company, all accumulated vacation allowance, but no separation allowance.

With the drafting room equipped and organized as here suggested, there is little excuse for not being able to work or being stymied by lack of equipment. Most men have sufficient incentive to work to provide the necessities and luxuries for themselves and families and with the hope of receiving promotion.

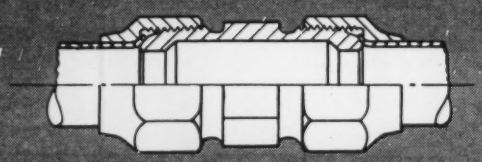
"THAT GAZIMPATATOR YOU DESIGNED IS OKAY EXCEPT FOR THESE FEW CHANGES!"

Tube Fittings

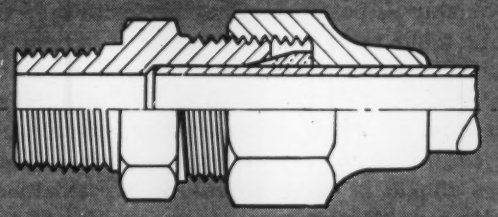
Various designs and methods of sealing available for fluid conveying systems in machines

SELECTION of the proper fitting or fittings to be used on a particular type of hydraulic, lubrication, coolant or other machine fluid line must of necessity involve consideration of the service to be encountered, environment, fluid, pressure, installation, maintenance, replacement, and similar factors. A wide variety of designs is available from which a fitting may be selected to suit almost any condition encountered.

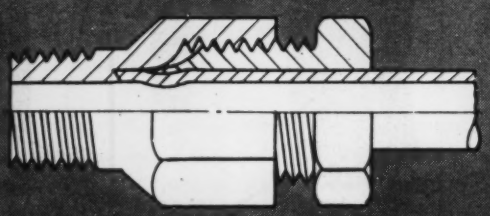
To show the various types of fittings commercially available and their basic design characteristics, MACHINE DESIGN has prepared this pictorial article. The cross section of each fitting or connection shows the type of joint obtained and, where necessary, the method of preparing the tubing to be connected. In general, all tube fittings are specified in sizes which indicate the outside diameter of the tubing for which the fitting is designed.



DESIGNED for connections with soft copper tubing, the Anaconda cast bronze flared tube fittings utilize a rounded seal nose. Particularly intended for fire sprinkler systems, underground water and gas lines, oil burner and supply lines, and similar applications, the fittings are available in elbows, tees, couplings and a full range of reduction or adapter combinations in sizes from ⅜-inch to 2 inches, inclusive.

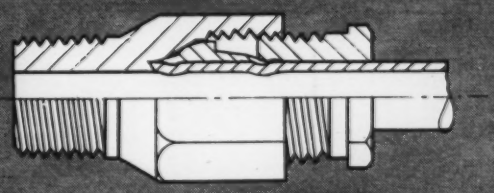


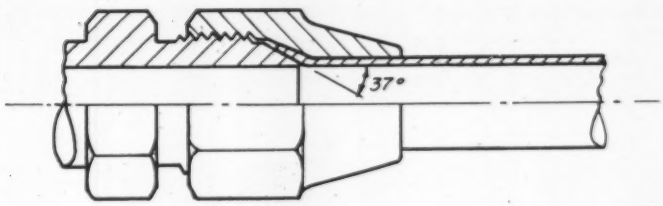
A COMPRESSION type fitting, the Lunkenheimer tube connector utilizes a sharply tapered wedge to contact and seal on the tube when the nut is tightened. Made in brass, the usual range of fitting combinations are available in sizes to suit ⅛ to ⅝-inch tubing.



THE DOLE double-compression fitting has been widely used for many years in automotive and other equipment. The completed joint seals both at the wedge and at the tube-end shoulder. Generally made in brass, the fittings are available in a complete range of connectors, elbows, tees, unions, and adapters in sizes from ⅛ to ¾-inch, inclusive.

THE DOLE All-Tube coupling is a compression type fitting designed for use with any type tubing, seamed or seamless, whether brass, aluminum, copper or steel. The nut consists of two pieces held together with a touch of solder. When completed, the joint seals at three places, both ends of the compression sleeve forming a crimp in the tube. Available in a full range of fitting designs, the units are generally made of brass in sizes from ⅛ to ⅝-inch, inclusive.

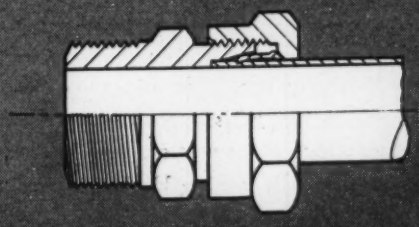




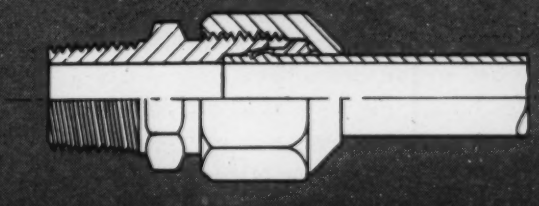
JIC STANDARD FITTING DESIGN

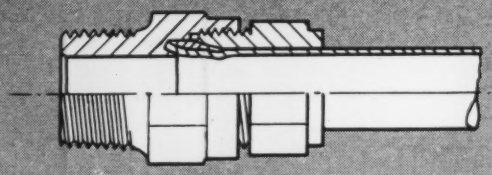
DESIGN and application of tube fittings has long been a point of discussion and controversy, especially between aircraft manufacturers and the various Air Arms of the Armed Services. As a result of standardization activities in the Army and Navy Air Corps, a unified standard type of tube fitting seal nose design has been adopted. This design constitutes a general compromise between the ideal desired and various practical limitations such as stretch in flaring the tubing, etc. Following this general standard, the Joint Industry Conference on Hydraulic Standards for Industrial Equipment has developed a parallel general standard which will satisfy not only aircraft requirements but also general industrial needs. The various types and sizes of this JIC Standard are covered in the Data Sheet on Page 133 of this issue. These standard fittings will be available from most manufacturers and may vary slightly in basic types but conform in seal nose design and overall performance to the major required specifications.

THE WEATHERHEAD Ermeto fitting utilizes the shearing action from a machined sleeve edge to effect a leakproof joint. Designed for high pressures and resistance to vibration, the fittings are recommended for any rigid tubing other than annealed copper — steel, stainless steel, iron, brass Monel, aluminum, or ¼ to full-hard copper. Standard fittings are made from steel and cover a range from ⅛-inch through 1½ inches in a full complement of connectors, elbows, tees, unions, and adapters.

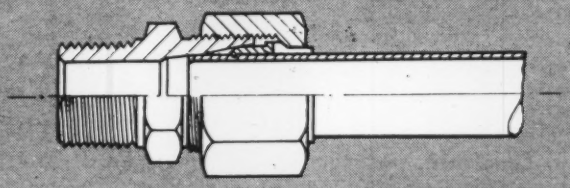


PARKER Ferulok couplings for heavy-wall tubing produce a seal by turning up a shoulder on the tube during tightening. Designed for tubing which cannot be flared readily, the fittings can be used with all grades of commercial welded or seamless tubing. Made from steel, standard fittings are available in sizes from ⅛ to 1-inch with a full range of shapes — nipples, unions, elbows, tees, etc.

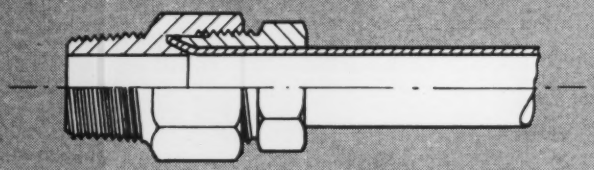




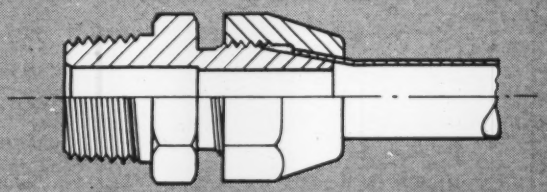
THE SCOVILL Uniflare tube fitting forms its own flare as the joint is tightened. The small compression sleeve is originally a part of the nut. On tightening, the sleeve shears from the nut and is compressed radially into the tube to carry the tube forward and create the flare. The seal nose is within the fitting in a protected position and has the approved JIC Standard 37-degree nose angle. Standard fitting types are available in brass, steel and aluminum in sizes ranging from ⅛ through ¾-inch for annealed steel, copper, brass, aluminum, or Monel tubing.



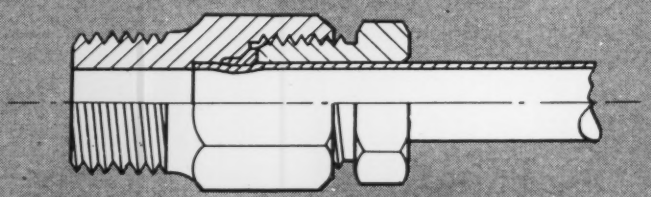
THE FLODAR Fluid Fortress type tube fitting requires no flare for sealing. Tightening of the nut forces the floating sleeve down the taper and impresses the V-shape rib into the tube surface, wedging the tube end down the taper. The slotted sleeve end has a collet action to grip the tube and resist vibration fatigue. Sleeves are heat-treated chrome-molybdenum steel and bodies are low-carbon steel. The standard range of fitting types is available in sizes from ¼-inch to 1½ inches, inclusive.



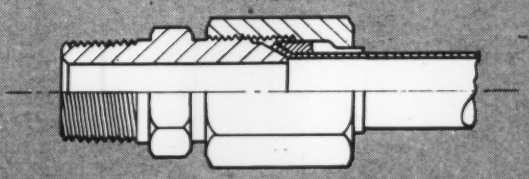
THE PARKER inverted type flared tube couplings utilize a 30-degree seal nose situated within the body. The sealing seat on these fittings is protected against damage and a minimum length of fitting as well as a longer sealing surface results. Both standard and heavyweight tubing fittings are available: the standard in sizes from ⅛-inch to 1 inch and the heavy in sizes from ¼-inch to 1 inch.



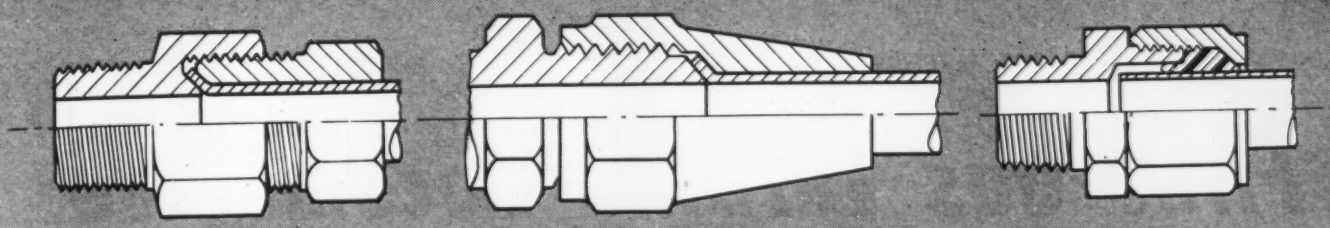
GRINNELL Superseal tube fittings utilize a long, smooth 10-degree seal nose and are designed for high-pressure applications where vibration is present. Full safe pressure for the tubing used can be employed and the fittings are approved for use with all hazardous gas and liquid service. Standard fittings are made in brass and steel; malleable iron, aluminum or alloys are furnished on order. Sizes range from 3/16 to ½-inch, inclusive, in standard types



IMPERIAL Hi-Duty fittings are a compression seal type on which the compression sleeve, originally part of the nut, shears away during tightening. For medium-pressure work, the fittings are used for gas, oil, grease, vacuum, and air lines where minor vibration may be present. Fittings are of brass and can be used with all types of tubing although aluminum fittings are made especially for aluminum tubing applications. Standard range of fitting styles is available in brass for sizes from ⅛ to ¾-inch inclusive and in aluminum for sizes from 3/16 to ½-inch, inclusive.



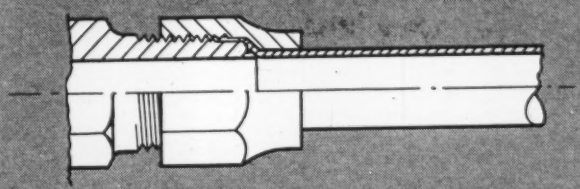
FLODAR Griptube fittings utilize a floating sleeve within the tube nut which is made of heat-treated chrome-molybdenum steel. The portion which contacts the flare is solid whereas the other end is slotted so that the tube nut creates a collet action to hold the tube on tightening and resist vibration. The 37-degree seal nose as well as fitting performance conforms to the JIC standards. Made in steel, the usual standard types of connectors and couplings are available in sizes from ¼-inch to 1½ inches, inclusive.



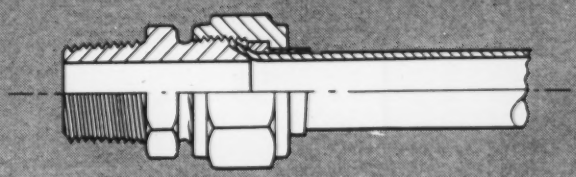
THE WEATHERHEAD inverted type of flared tube coupling has the sealing seat situated within the fitting body to protect it against damage. Similar to that of the standard SAE seal nose, the seat has a 45-degree angle. A fitting of minimum overall length results with this design. A full range of connector styles is available from ⅛ through 1-inch with brass bodies and steel nuts. Brass nuts can be furnished when desirable.

STANDARD SAE flared tube fitting, long used for applications in the automotive and service industries, utilizes a 45-degree seal nose. For low, medium and high-pressure applications on liquids or gases, the fittings can be used with any type soft tubing which can be flared. The usual range of fitting types in brass are available for tube sizes ranging from ⅛-inch to ¾-inch, inclusive.

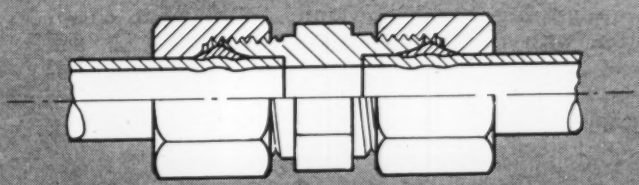
IMPERIAL Flex Fittings employ a synthetic elastic sleeve for tube joints where movement, vibration or shock is prevalent. For low and medium-pressure gas, oil or air lines, the fittings require no flare up to ½-inch sizes. On medium-pressure work and on sizes over ½-inch, a slight bell is recommended for the tube end. Made in brass the fittings are available in the usual range of styles for all varieties of tubing from ⅛-inch through ¾-inch.



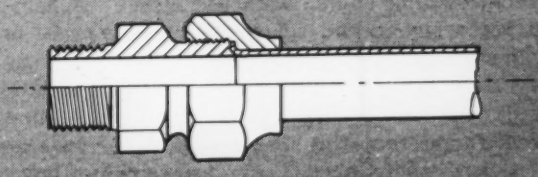
IMPERIAL heavy-duty flared tube fittings are basically SAE type connectors but are heavier in all respects to suit high-pressure work where heavy-wall tubing is used. On sizes ⅜-inch and over, a triple-seal feature is used to insure positive sealing. The 45-degree seal nose is grooved to permit the tubing to extrude into the nose for additional safety. For copper, brass, aluminum, and steel tubing in heavy-wall sizes, brass fittings are available in tee, elbow, and connector styles in sizes from 3/16 through ¾-inch.



PARKER Triple type tube couplings provide a special support sleeve for the tubing which prevents the nut from wiping directly over the flare. A 30-degree nose angle is used to give a longer seal surface, making the fittings particularly suitable for soft copper and aluminum tubing. Made in brass, a complete range of coupling types from ⅛-inch to 1½-inch is available for standard weight tubing and from ¼-inch to 1 inch for heavyweight tubing. A variation of this design having a 37-degree nose angle, termed Triple-lok, conforms to the JIC standards and is made in steel and stainless steel. Aluminum fittings specifically intended for aircraft are also available which meet AN as well as JIC standards.



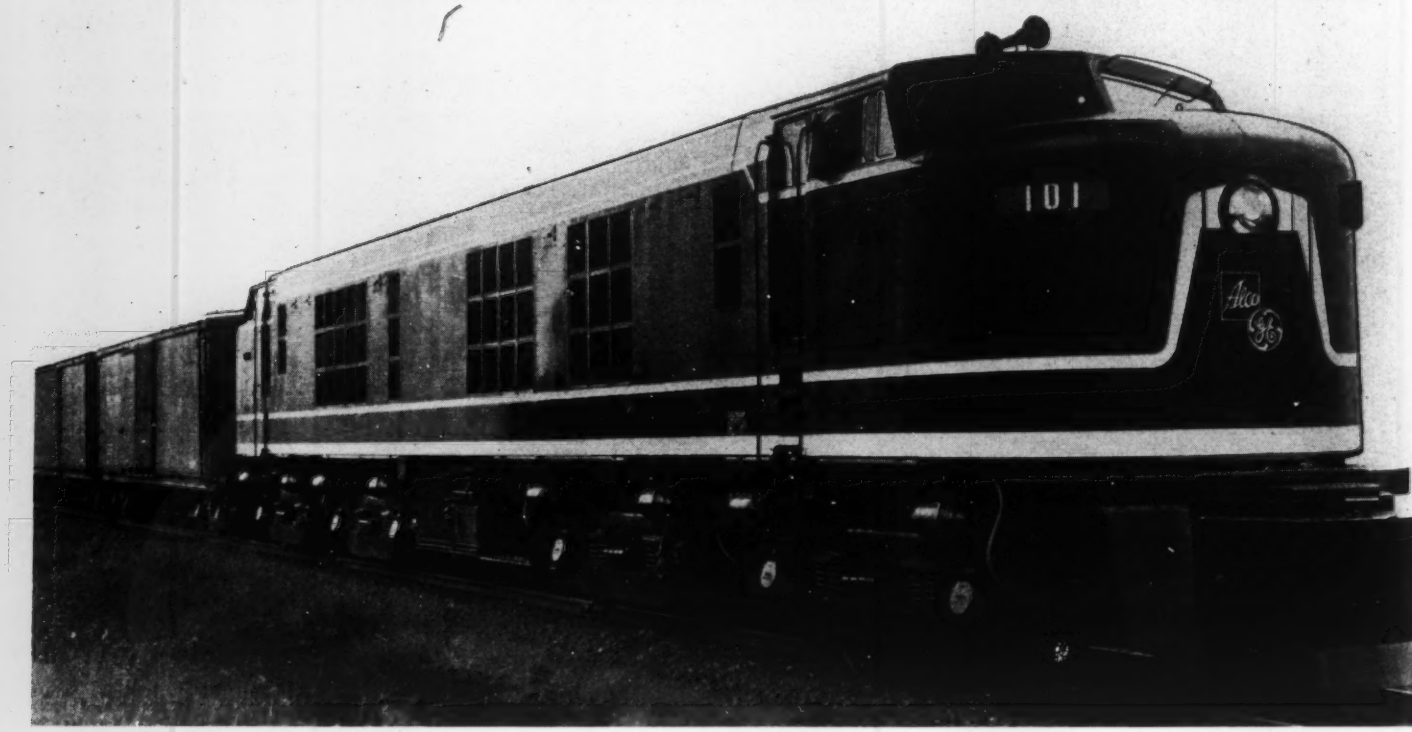
STANDARD compression-sleeve fitting has a small tapered sleeve which is slipped over the tube in assembly. No flare is required and the sleeve is swedged onto the tube at both ends to effect a seal on tightening. For low-pressure applications, the fittings are used for gas, oil, vacuum, and air lines where excessive vibration is not present. Standard sizes range from ⅛ through ¾-inch in the usual series of fitting styles.



HAYS Double-Seal copper tube fittings utilize a 45 and 90-degree combination seal surface. Designed primarily for plumbing and low-pressure hydraulic systems, the fittings are also used for conveying steam, gases, gaseous fuels, and petroleum products. Ordinary fittings are of cast red brass but can also be furnished in other metals to suit the application. All tube threads are straight pipe threads one size larger than nominal fitting size to permit intercoupling with regular piping systems where necessary. Sizes range from ¼-inch through 2-inch in a range of standard fitting types including integral bracket fittings.

First Gas Turbine Locomotive

. . . built and operated in this country completes preliminary road trials



RESEARCH and development for new and better products is a slow and probing quest, especially in the heavy industries. Railroad motive power is no exception. Almost half a century of development was necessary to displace the tried-and-true steam reciprocating engine with the diesel. Generally good performance and relatively high thermal efficiency permit the diesel to remain, at present, unrivaled. Railroads traversing coal regions and depending largely on coal carrying for revenue, however, have found that the oil-burning diesel does not wholly satisfy their needs. A coal-burning power plant with performance equal to or better than that of the diesel would fulfill the requirements.

Time-consuming and expensive study have resulted in the development of the oil-burning gas turbine to the point where it is widely accepted by the aircraft field and to a limited extent in certain branches of industrial power. Possibility of its adaptation to coal burning has given rise to the hope that here is the answer the railroads have sought.

Justification for such optimism can be more precisely measured now, for the General Electric Co. has applied its knowledge of the aircraft gas turbine to the design of a locomotive unit. Working in co-operation with the American Locomotive Co., it has placed in operation the first locomotive in this country to house a gas turbine power plant, *Fig.* 1. Sixteen hundred miles of road tests have been completed.

Fig. 1—Top—Alco-GE development 4500-hp gas turbine locomotive during track tests at General Electric plant in Erie, Pa. This is the first gas turbine-powered locomotive to be built and operated in this country

TABLE I—**Locomotive Particulars**

Double-end, single-unit, road freight type

Horsepower rating, hp	4,500
Tractive effort, continuous, at 20.5 mph, lb	68,500
Tractive effort at 25% adhesion, lb	125,000
Maximum speed, mph	79
Height, ft	15
Weight on drivers, lb	500,000
Width over hand rails, ft	10
Length inside knuckles, ft	83
Horsepower per ft of length	53
Classification	B-B-B-B
Fuel capacity at 4500 hp, hours of operation	12
Wheelbase, total, ft	63
Maximum track curvature, degrees	21
Wheel diameter, in.	42
Axles, all driving	8
Traction motors, d-c	8

LOCOMOTIVE AND TURBINE SPECIFICATIONS: Leading features of the locomotive are given in TABLE I. Construction of this locomotive generally follows standard practice. Of prime interest, therefore, is the power plant whose specifications are listed separately in TABLE II.

As can be seen from *Fig.* 2, the general arrangement of the open-cycle power plant is somewhat similar to that of an aircraft gas turbine. Straight through, in-line arrangement of compressor, combustion chambers and turbine results in maximum simplicity and minimum pressure losses. The gas turbine is connected through gearing to four d-c generators providing power for the eight traction motors. Motor speed is controlled by a GE power plant vari-

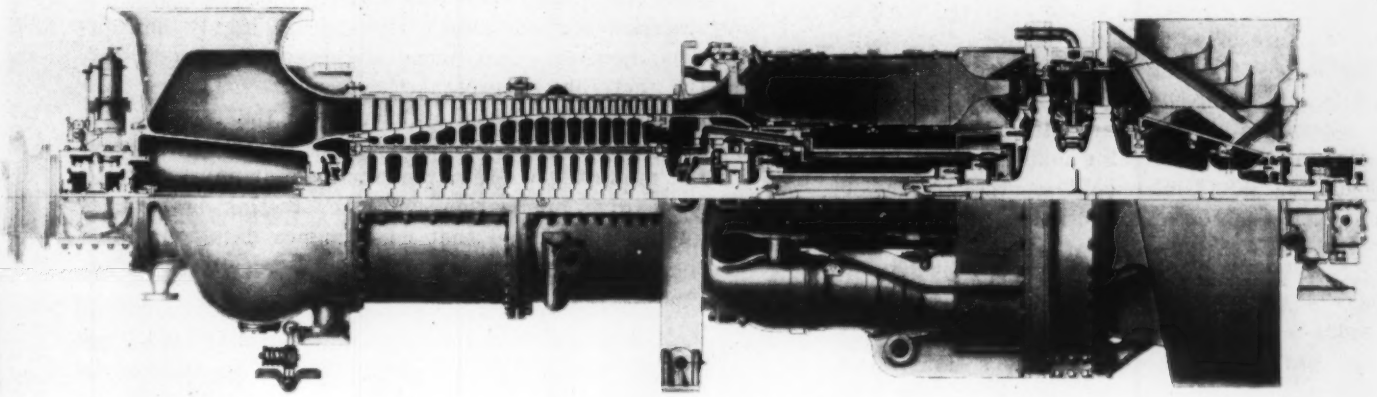
TABLE II—Gas Turbine Specifications[1]

In-line, axial-flow, combustion type

Horsepower rating	4,800
Shaft output rating, kw	3,500
Weight, lb	25,000
Overall length, ft	19
Overall width, ft	6.75
Turbine inlet temperature, F	1,400
Ratio of weight to horsepower, lb per hp	5
Compressor pressure, atmospheres gage	5
Overall thermal efficiency, %	17
RPM at rated shp	6,700
Designed altitude for rating, ft	1,500
Ambient air temperature for rating, F	80
Fuel	Bunker C
Starting fuel	Diesel
Air intake rate, cfm	80,000

[1] Alan Howard—"Design Features of a 4800-HP Locomotive Gas Turbine Power Plant", paper presented at semiannual meeting of American Society of Mechanical Engineers, June 15-20, 1947, Chicago.

Fig. 2—Cross section through gas turbine power plant. Air is drawn through a compressor into several combustion chambers where fuel is injected and the mixture is burned. Burning of the fuel raises the temperature of the compressed air. Resulting gases are then expanded and move at high velocity against the turbine buckets, turning the shaft. Power from the turbine wheel drives the load as well as the compressor rotor



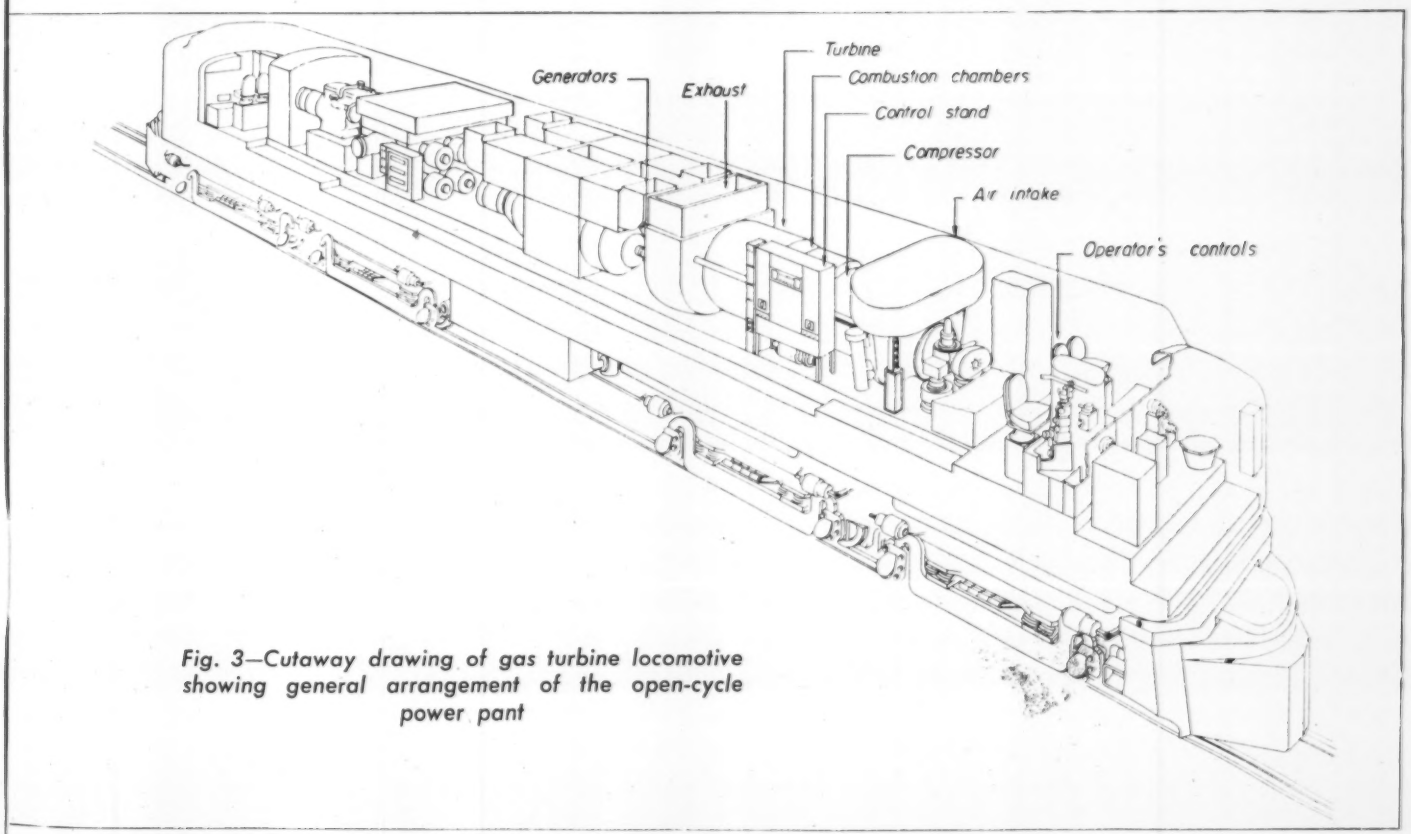


Fig. 3—Cutaway drawing of gas turbine locomotive showing general arrangement of the open-cycle power pant

First Gas Turbine Locomotive

. . . built and operated in this country completes preliminary road trials

RESEARCH and development for new and better products is a slow and probing quest, especially in the heavy industries. Railroad motive power is no exception. Almost half a century of development was necessary to displace the tried-and-true steam reciprocating engine with the diesel. Generally good performance and relatively high thermal efficiency permit the diesel to remain, at present, unrivaled. Railroads traversing coal regions and depending largely on coal carrying for revenue, however, have found that the oil-burning diesel does not wholly satisfy their needs. A coal-burning power plant with performance equal to or better than that of the diesel would fulfill the requirements.

Time-consuming and expensive study have resulted in the development of the oil-burning gas turbine to the point where it is widely accepted by the aircraft field and to a limited extent in certain branches of industrial power. Possibility of its adaptation to coal burning has given rise to the hope that here is the answer the railroads have sought.

Justification for such optimism can be more precisely measured now, for the General Electric Co. has applied its knowledge of the aircraft gas turbine to the design of a locomotive unit. Working in co-operation with the American Locomotive Co., it has placed in operation the first locomotive in this country to house a gas turbine power plant, *Fig.* 1. Sixteen hundred miles of road tests have been completed.

Fig. 1—Top—Alco-GE development 4500-hp gas turbine locomotive during track tests at General Electric plant in Erie, Pa. This is the first gas turbine-powered locomotive to be built and operated in this country

TABLE I—Locomotive Particulars

Double-end, single-unit, road freight type

Horsepower rating, hp	4,500
Tractive effort, continuous, at 20.5 mph, lb	68,500
Tractive effort at 25% adhesion, lb	125,000
Maximum speed, mph	79
Height, ft	15
Weight on drivers, lb	500,000
Width over hand rails, ft	10
Length inside knuckles, ft	83
Horsepower per ft of length	53
Classification	B-B-B-B
Fuel capacity at 4500 hp, hours of operation	12
Wheelbase, total, ft	63
Maximum track curvature, degrees	21
Wheel diameter, in.	42
Axles, all driving	8
Traction motors, d-c	8

LOCOMOTIVE AND TURBINE SPECIFICATIONS: Leading features of the locomotive are given in TABLE I. Construction of this locomotive generally follows standard practice. Of prime interest, therefore, is the power plant whose specifications are listed separately in TABLE II.

As can be seen from *Fig.* 2, the general arrangement of the open-cycle power plant is somewhat similar to that of an aircraft gas turbine. Straight through, in-line arrangement of compressor, combustion chambers and turbine results in maximum simplicity and minimum pressure losses. The gas turbine is connected through gearing to four d-c generators providing power for the eight traction motors. Motor speed is controlled by a GE power plant vari-

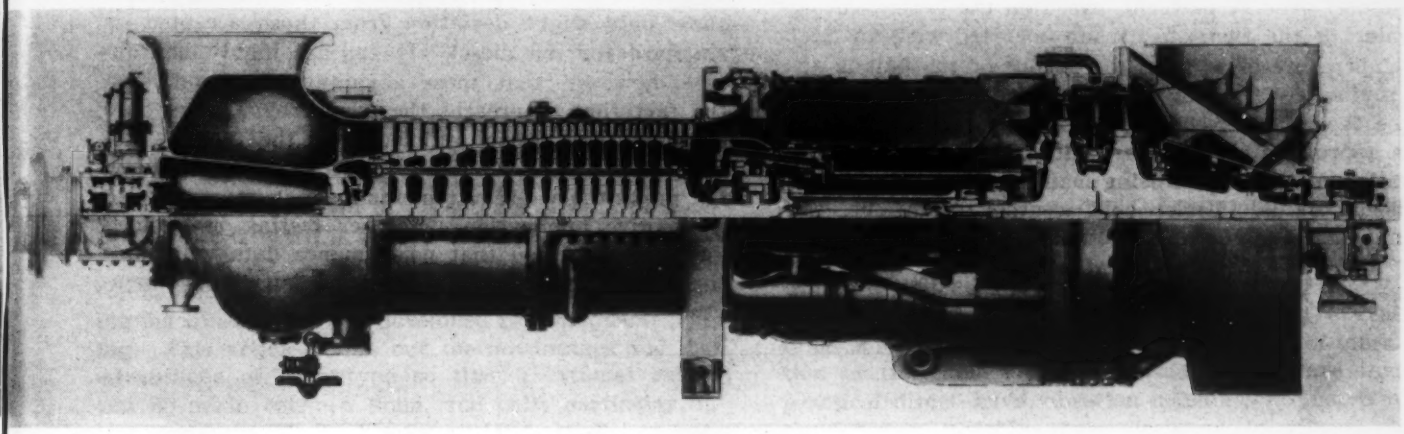
TABLE II—Gas Turbine Specifications[1]

In-line, axial-flow, combustion type

Horsepower rating	4,800
Shaft output rating, kw	3,500
Weight, lb	25,000
Overall length, ft	19
Overall width, ft	6.75
Turbine inlet temperature, F	1,400
Ratio of weight to horsepower, lb per hp	5
Compressor pressure, atmospheres gage	5
Overall thermal efficiency, %	17
RPM at rated shp	6,700
Designed altitude for rating, ft	1,500
Ambient air temperature for rating, F	80
Fuel	Bunker C
Starting fuel	Diesel
Air intake rate, cfm	80,000

[1] Alan Howard—"Design Features of a 4800-HP Locomotive Gas Turbine Power Plant", paper presented at semiannual meeting of American Society of Mechanical Engineers, June 15-20, 1947, Chicago.

Fig. 2—Cross section through gas turbine power plant. Air is drawn through a compressor into several combustion chambers where fuel is injected and the mixture is burned. Burning of the fuel raises the temperature of the compressed air. Resulting gases are then expanded and move at high velocity against the turbine buckets, turning the shaft. Power from the turbine wheel drives the load as well as the compressor rotor



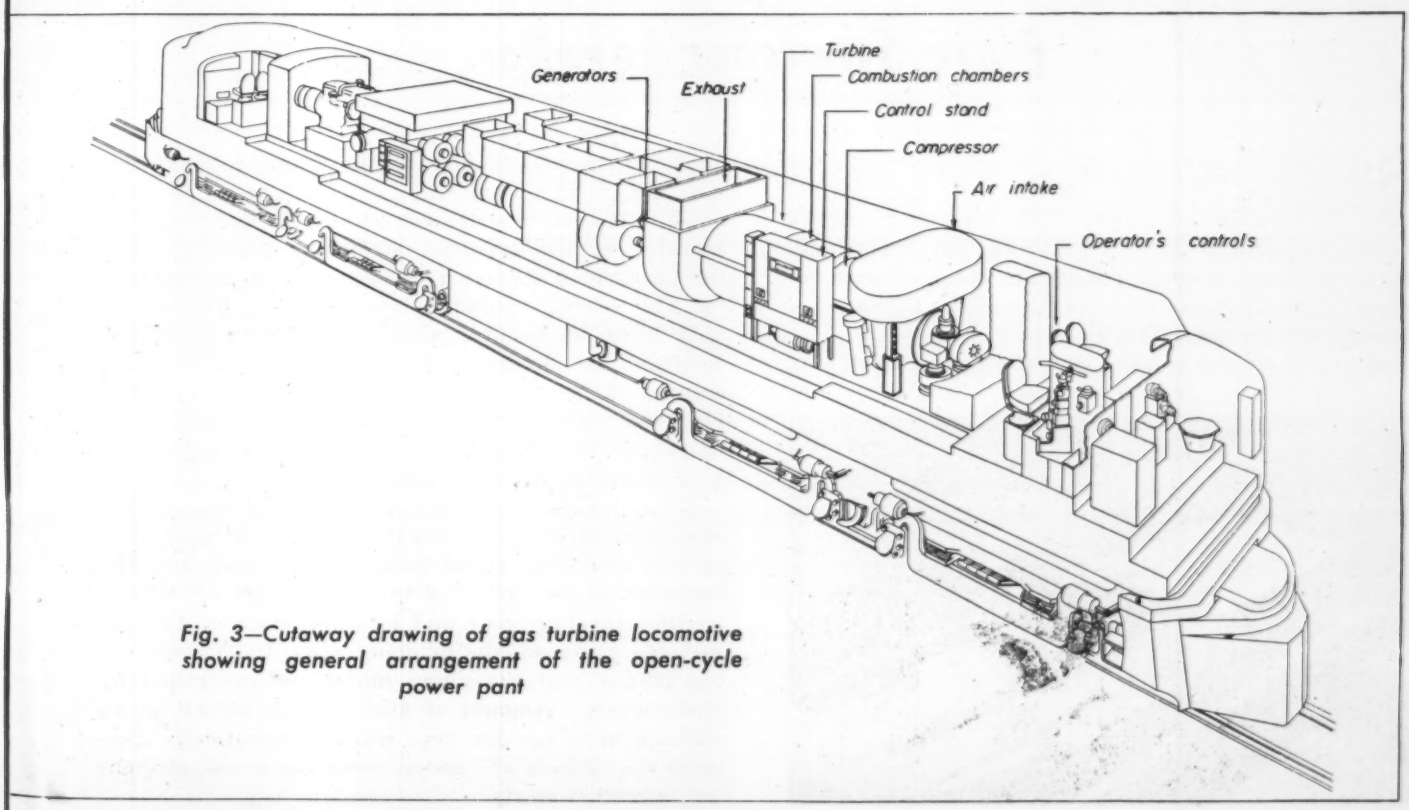


Fig. 3—Cutaway drawing of gas turbine locomotive showing general arrangement of the open-cycle power pant

able speed regulator.

TEST RESULTS: Prior to the road trials, the power plant was subjected to approximately 700 hours of operation in the development laboratory under simulated heavy railway service. Generally, the road tests and laboratory tests compared closely. Test performance, operating experiences and laboratory problems have been reported by Alan Howard.[2]

"After the first 100 hours during which all operation was on diesel fuel, about 80 per cent of the operating time has been on grade 6 fuel oil, and the remaining 20 per cent on diesel fuel oil. The results of this experience are considered definitely encouraging with, as generally expected, some troubles having been encountered. The indications are that no major design changes will be required.

". . . The unit delivers its rated power with an estimated turbine inlet temperature of about 1300 F compared to the design temperature of 1400 F. At the rated power condition, the thermal efficiency is slightly over 17 per cent, based on the lower heating value of the fuel. . . . When operated with an inlet temperature of 1400 F, the output of the unit is approximately 6000 hp or 120 per cent of rating, and the thermal efficiency, based on lower heating value, is approximately 18.5 per cent. For the present, the rating of the unit is being maintained at the original design value. Under cold weather conditions, the unit has been run at an actual output of 6400 hp.

[2] "Test of a 4800-HP Gas Turbine Power Plant", paper presented at the annual meeting of American Society of Mechanical Engineers, Nov. 29-Dec. 3, 1948, New York, N. Y.

"In general, the mechanical operation has been good with very little vibration or expansion trouble encountered. Combustion efficiency is high, 96 per cent and above, and after a few initial difficulties there has been essentially no trouble with carbon or combustion troubles."

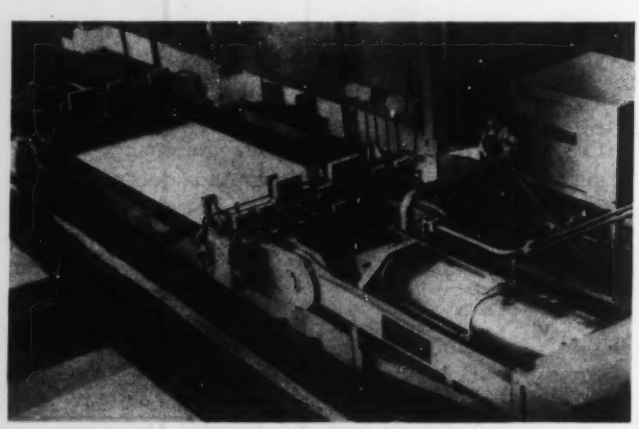
CONCLUSIONS: Although testing has been extensive, the results cannot be said to be conclusive of the gas turbine potentialities. Immediately evident is the fact that the unit must show improved thermodynamic performance before it can become a serious rival to the diesel in the locomotive field, despite the fact that it burns a lower-grade, cheaper fuel. Solution of certain combustion and ash problems may make it adaptable to coal burning and consequently more desirable from the standpoint of fuel used; it may develop into a better oil-burning unit. The power plant does offer possibilities of great reliability and low maintenance, and weighs less than one-half the diesel.

Most of the locomotive performance characteristics show only slight deviation from those accepted as standard for the diesel. It appears highly improbable, however, that these advantages can outweigh the fact that at present the gas turbine offers only one-half the thermal efficiency of the diesel. Regeneration could substantially raise this efficiency, but present space requirements make it impractical to locomotive application. Further testing is planned and it is expected that performance data will point the way toward design improvement leading to general acceptability.

Plate Stretcher-Leveller

STRETCHER-leveller recently incorporated into the production line of the Lukens Steel Co., Coatesville, Pa., has a capacity of 1000 tons and handles plates and sheets up to 11 ft wide and 31 ft long. By stretching, excellent results are obtained with respect to the flatness and properties of the plates, even on severely warped material.

A bed of welded construction absorbs all stretching forces so that the foundations have only to carry the dead weight of the machine. Two gripheads are provided. The main griphead shown in foreground is actuated by the hydraulic stretching cylinder, while the position of the other is adjustable to compensate for the varying length of the plates. This adjustable head is movable along the stretcher bed by means of an electric motor and suitable drive. It is secured in operating position by two heavy locking pins operated by air cylinders. Wedge-shaped shoes of special design in the throat of the gripheads insure firm gripping of the plates.



All movements and actions are performed by remote control from the operating panel. A hand lever on the operating stand governs the speed and the direction of movement of the main griphead, whereas the traveling gear and locking device of the adjustable griphead, the gripping jaws, the straightening device, and the pump motor are controlled by pushbuttons. Amount of stretching is shown on an instrument of the dial type which automatically indicates the amount of stretch when the actual stretching operation starts.

Resonance Amplifies Forces in Vibration Machines

By J. Paul Walsh
Mechanics Division
Naval Research Laboratory
Washington, D. C.

IN THE development or acceptance testing of a device, it is often desirable to subject it to a vibration test, particularly if the equipment is intended for mobile use. Two general types of vibration testing machines have been developed for equipment testing. This article points out the advantages and disadvantages of each type so that a rational choice can be made between them, and calls particular attention to the effect of resonant loads on the operating characteristics and on the design of vibration testing machines.

The two general classes of vibration machines, illustrated diagramatically in *Figs.* 1 and 2 are commonly called direct-drive and reaction types. The fundamental difference between the two is in the method of driving the table; each name indicates the drive used. In a direct-drive machine, the table is positively displaced by a cam, crank, or some other equivalent linkage. Table of a reaction machine is mounted on springs and driven by the oscillating force resulting from the rotation of the unbalanced rotor attached to the table. The natural frequency of a table on springs is less than the minimum operating frequency of the machine.

Each of these types has certain characteristic advantages and disadvantages. Advantages of the direct-drive machine are that the amplitude of the table is substantially constant, and direction of vibration of the table is fixed. Disadvantages are that practical direct-drive vibration machines are complex mechanisms, notably those designed to vibrate in more than one direction (i.e. horizontal and vertical), and an elaborate vibration isolating base is almost always required to reduce the forces transmitted to the surrounding structure.

In a reaction machine, advantages are that it is a relatively simple mechanism and, since the table is vibration-isolated from the surrounding structure by virtue of the "low frequency" mounting of the table, no vibration-isolating base is required.

Fig. 1—Diagram showing direct-drive vibration machine. Table is positively displaced by mechanical linkage

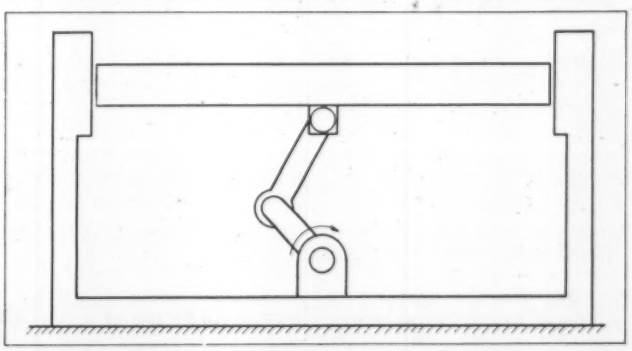
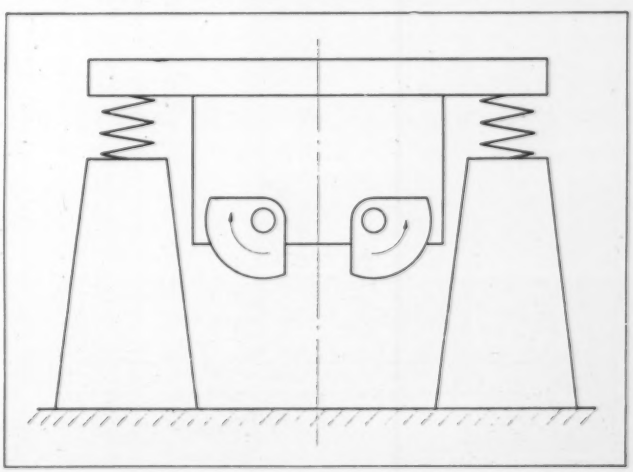


Fig. 2—Diagram of reaction type vibration machine. Driving force results from rotation of unbalanced rotors



The most serious disadvantage of the reaction type machine is that amplitude of the table is affected by the load being vibrated. Operating characteristics of a reaction machine vibrating a resonant load can be understood by applying the well-known theory of a tuned vibration absorber. Equations and curves given by Den Hartog* show that as the operating frequency of the machine approaches the natural frequency of the load (the absorber) the amplitude of the table will be reduced, and that near the resonant frequency of the load the amplitude of the table reaches a minimum value. If zero damping is present the amplitude is reduced to zero; for practical amounts of damping the amplitude is reduced to some small value.

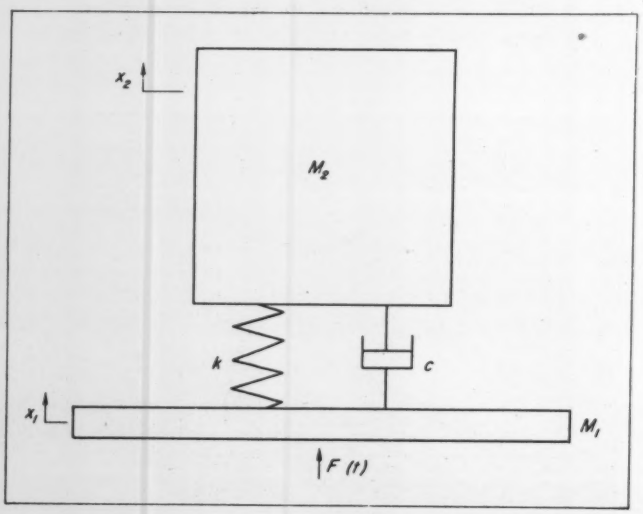
Most specifications require that apparatus be subjected to vibrations of some fixed amplitude through a given frequency range. At the resonant frequency of the equipment (where presumably a large percentage of failures will take place) the amplitude of the table becomes small, and the amplitude of the equipment reaches some value which is a function of the weight of the testing-machine table and the weight of the load. This is considered to be a serious drawback to the use of reaction type machines.

In the neighborhood of the natural frequency of the load, on a direct-drive machine, this tuned-vibration-absorber effect also takes place, but the table amplitude cannot become small because it is fixed. Instead, the forces necessary to drive the machine become large; hence the bearing, table, and driving mechanism design is affected by this tuned-vibration-absorber effect.

In order to examine the forces acting on direct-drive vibration machines in the neighborhood of a resonant frequency of the load, consider the case represented diagramatically in *Fig.* 3. Table and load are supported by a spring and dashpot, with the load considered to be in a single-degree-of-freedom system. Referring to the Nomenclature, the equations of motion of this system are:

* J. P. Den Hartog—*Mechanical Vibrations*, McGraw-Hill Book Co., New York, 2nd Edition, 1940, Page 115.

Fig. 3—Idealized direct-drive vibration machine. Table and load are supported by spring and dashpot



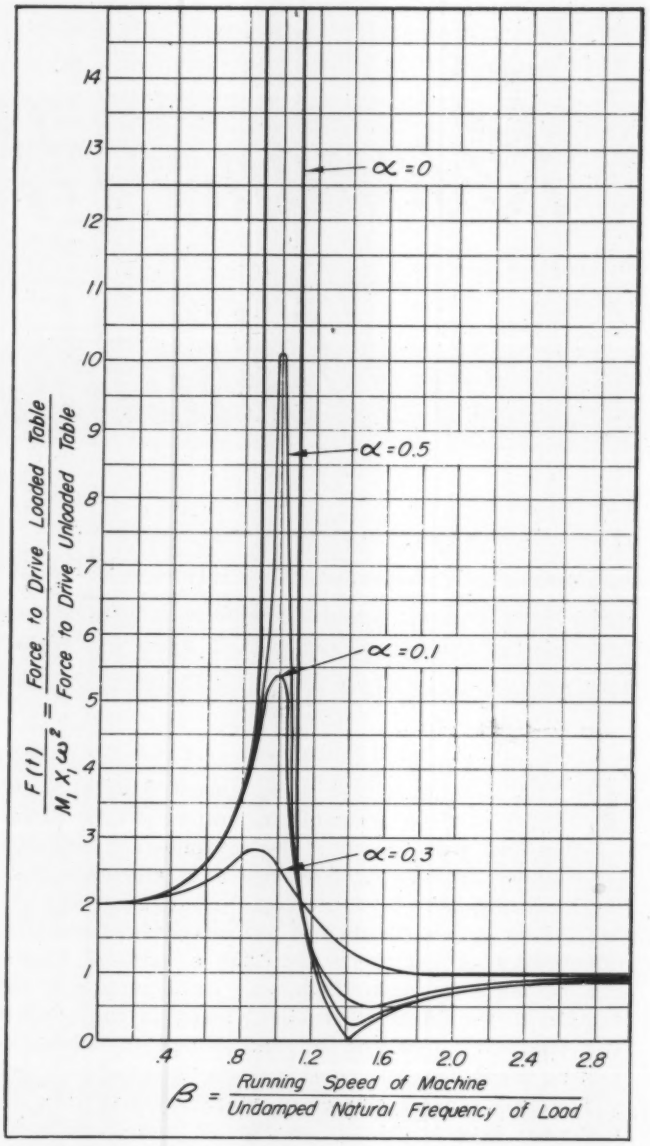


Fig. 4 — Force characteristics of direct-drive machine. Curves show ratio of force required to drive loaded table to force required to drive unloaded table

$$k(x_1 - x_2) + c\left(\frac{dx_1}{dt} - \frac{dx_2}{dt}\right) - M_2\frac{d^2x_2}{dt^2} = 0 \quad \ldots (1)$$

and

$$k(x_1 - x_2) + c\left(\frac{dx_1}{dt} - \frac{dx_2}{dt}\right) + M_1\frac{d^2x_1}{dt^2} = F(t) \quad (2)$$

Letting $u = x_1 - x_2$, Equations 1 and 2 become

$$M_2\frac{d^2u}{dt^2} + c\frac{du}{dt} + ku = M_2\frac{d^2x_1}{dt^2} \quad \ldots\ldots (3)$$

and

$$M_1\frac{d^2x_1}{dt^2} + c\frac{du}{dt} + ku = F(t) \quad \ldots\ldots (4)$$

Equation 3 can be written

$$\frac{d^2u}{dt^2} + \frac{c}{M_2}\frac{du}{dt} + \frac{k}{M_2}u = -\omega^2 X_1 \sin \omega t \quad \ldots\ldots (5)$$

Nomenclature

M_1 = Mass of table, including effective mass of cranks, etc., attached to table
M_2 = Mass of load
k = Spring constant, force per unit deflection
c = Coefficient of damping, force per unit velocity
$F(t)$ = Force on the table from driving mechanism
x_1 = Displacement of table = $X_1 \sin \omega t$, where X_1 is amplitude
$\alpha = c/c_c = c/2\sqrt{kM_2}$ = Ratio of damping in mount to critical damping
$\beta = \omega\sqrt{k/M_2}$ = Ratio of operating frequency of the vibration machine to undamped natural frequency of the load
$\mu = M_2/M_1$ = Ratio of mass of load to mass of table.

Solving Equation 5 gives the following expression for u,

$$u = \frac{-\beta^2 X_1 (1-\beta^2)}{(1-\beta^2)^2 + (2\alpha\beta)^2} \sin \omega t + \frac{\beta^2 X_1 (2\alpha\beta)}{(1-\beta^2)^2 + (2\alpha\beta)^2} \times \cos \omega t \quad \ldots\ldots (6)$$

From Equation 4

$$F(t) = M_1 \frac{d^2x_1}{dt^2} + c\frac{du}{dt} + ku$$

The acceleration d^2x_1/dt^2 of the vibrating platform is known, and u and du/dt can be found from Equation 6. These terms added together as directed by Equation 4 determine the value of $F(t)$. An alternative method is to rewrite Equation 3 as

$$c\frac{du}{dt} + ku = M_2 \frac{d^2x_1}{dt^2} - M_2 \frac{d^2u}{dt^2} \quad \ldots\ldots (7)$$

Substituting for $c(du/dt) + ku$ in Equation 4,

$$F(t) = M_1 \frac{d^2x_1}{dt^2} + M_2 \frac{d^2x_1}{dt^2} - M_2 \frac{d^2u}{dt^2} \quad \ldots\ldots (8)$$

$$F(t) = M_1 \left[(1+\mu) \frac{d^2x_1}{dt^2} - \mu \frac{d^2u}{dt^2} \right] \quad \ldots\ldots (9)$$

where

$$\mu = \frac{M_2}{M_1}$$

Substituting d^2x_1/dt^2 and d^2u/dt^2 in Equation 9 and solving for the absolute value of $F(t)$, it follows that

$$\frac{F(t)}{M_1\omega^2 X_1} = \left\{ \left[(1+\mu) + \frac{\mu\beta^2 (1-\beta^2)}{(1-\beta^2)^2 + (2\alpha\beta)^2} \right]^2 + \left[\frac{\mu\beta^2 (2\alpha\beta)}{(1-\beta^2)^2 + (2\alpha\beta)^2} \right]^2 \right\}^{1/2} \quad \ldots\ldots (10)$$

This equation represents the ratio of the force required to drive the loaded table to the force required to drive the unloaded table. This equation is plotted in *Fig.* 4 for a mass ratio of one ($\mu = 1$).

At operating speeds of the machine which are low compared with the natural frequency of the load, the load moves essentially as if it were rigidly attached to the table, and the force required to drive the table is approximately equal to the acceleration of the table multiplied by the sum of the mass of the table and of the load. At operating speeds which are much higher than the natural frequency of the load, the mounting isolates the load and the force required to drive the table approaches that required to drive the unloaded table.

In the neighborhood of the resonant frequency of the load the force required to drive the table through the prescribed displacement reaches a maximum value. At resonance the load can be considered to be a tuned-vibration-absorber doing its best to reduce the amplitude of the table by exerting high forces on it. *Fig.* 4 shows the values to which these forces can rise for various amounts of damping.

With testing equipment mounted on conventional shock or vibration mounts the force required to drive the table reaches values 15 to 20 times the value required if the load were rigidly attached to the table.

This article is based on Naval Research Laboratory Report 0-2267 "Some Considerations Concerning Vibration Machines and Vibration Measurements" by Irwin Vigness and J. P. Walsh. Ideas and opinions expressed are those of the author and are not necessarily those of the Navy Department.

More Aluminum Foil

NEW source of aluminum foil has become available with the start of production of the Permanente Metals Corp. plant near San Jose, California. The rolling mill shown is one of 16 which will contribute to the plant capacity of 500,000 to 750,000 pounds of foil per month.

Unified Tolerances Compared

Glen H. Stimson
Chief Engineer, Gage Division
Greenfield Tap and Die Corp.
Greenfield, Mass.

DIFFERENCES between the new unified standard screw threads adopted by the United States, Britain and Canada and those of the old American National standard may readily be visualized by inspection of the accompanying charts. In *Fig.* 1 is illustrated the relationship between the unified tolerances, and *Figs.* 2 and 3 are for comparison between the American National and unified tolerances.

The unified standard contains new Classes 1A, 2A and 3A tolerances for screws and Classes 1B, 2B and 3B tapped hole and nut tolerances in addition to the Class 2 and 3 tolerances given in the system used previously. An allowance is provided on Class 1A and 2A screws between the maximum screw pitch diameter and basic pitch diameter. Minimum screw and maximum tapped hole or nut pitch diameters are equal amounts below and above basic pitch diameter respectively. The tolerance for the screw is, therefore, smaller than that of the tapped hole or nut by the amount of the allowance.

American full form maximum screws will have slight interference at major diameter when assembled with British minimum major diameter tapped holes or nuts having maximum radius. Threading dies for producing unified Class 1A or 2A screws will be required to cut smaller by the amount of the allowance. Unified Class B minimum tapped hole or nut pitch diameter is basic for all classes of tolerance. Present tap pitch diameters should be suitable for producing any unified tapped hole or nut to any class of tolerance.

In the charts, pitch diameter tolerances are listed by one-thousandth inch increments at the left-hand side. Figures at the bottom of the charts represent the thread diameter range from No. 0 machine screw to 1½-inch inclusive. The central horizontal line represents the basic pitch diameter. Values above the basic line are diameter tolerance values for threaded holes. Those below the basic line represent diameter tolerances for screws.

As an example of the use of these charts for comparison, *Fig.* 3 compares 2A and 2B UNC pitch diameter tolerances with NC 1, NC 2 and NC 3 tolerances. From the chart the tolerance value for a ¼-inch-20 UNC-2B thread hole is 0.0048-inch while that for a ¼-inch-20 NC-2 is 0.0036-inch. Considering the screw tolerance it should be noted that the maximum 2A screw is under basic pitch diameter by the amount of an allowance. Applying the allowance to a ¼-inch-20 UNC-2A screw the maximum screw is 0.0011-inch under basic pitch diameter. The minimum 2A screw is under basic by 0.0048-inch. It at once becomes apparent that the tolerance of the 2A screw is smaller than the tolerance of the 2B threaded hole by the amount of the allowance. The resultant screw tolerance is 0.0037-inch or 0.0001-inch more than NC-2.

Fig. 1—Pitch diameter tolerances for coarse and fine pitch threads of unified standard screw threads

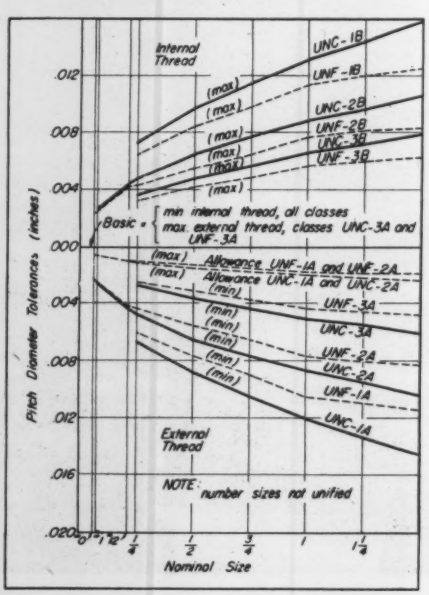


Fig. 2—Coarse thread tolerances. Comparison of Class 2A and 2B unified and Class 1, 2 and 3 National Coarse

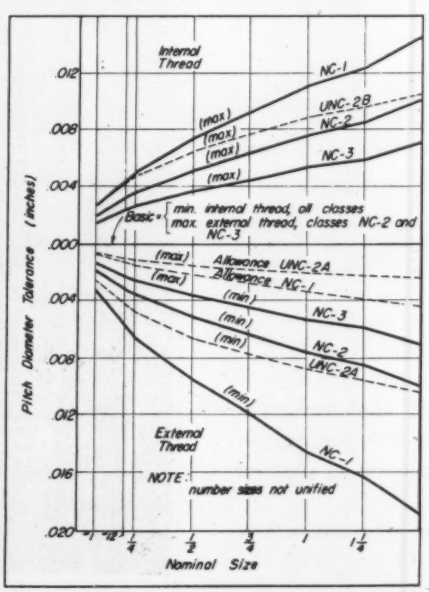
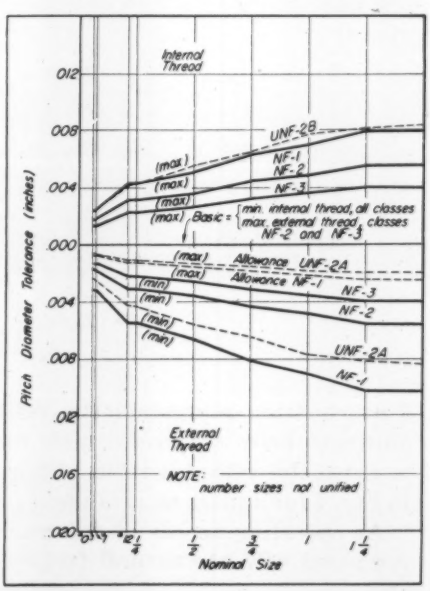
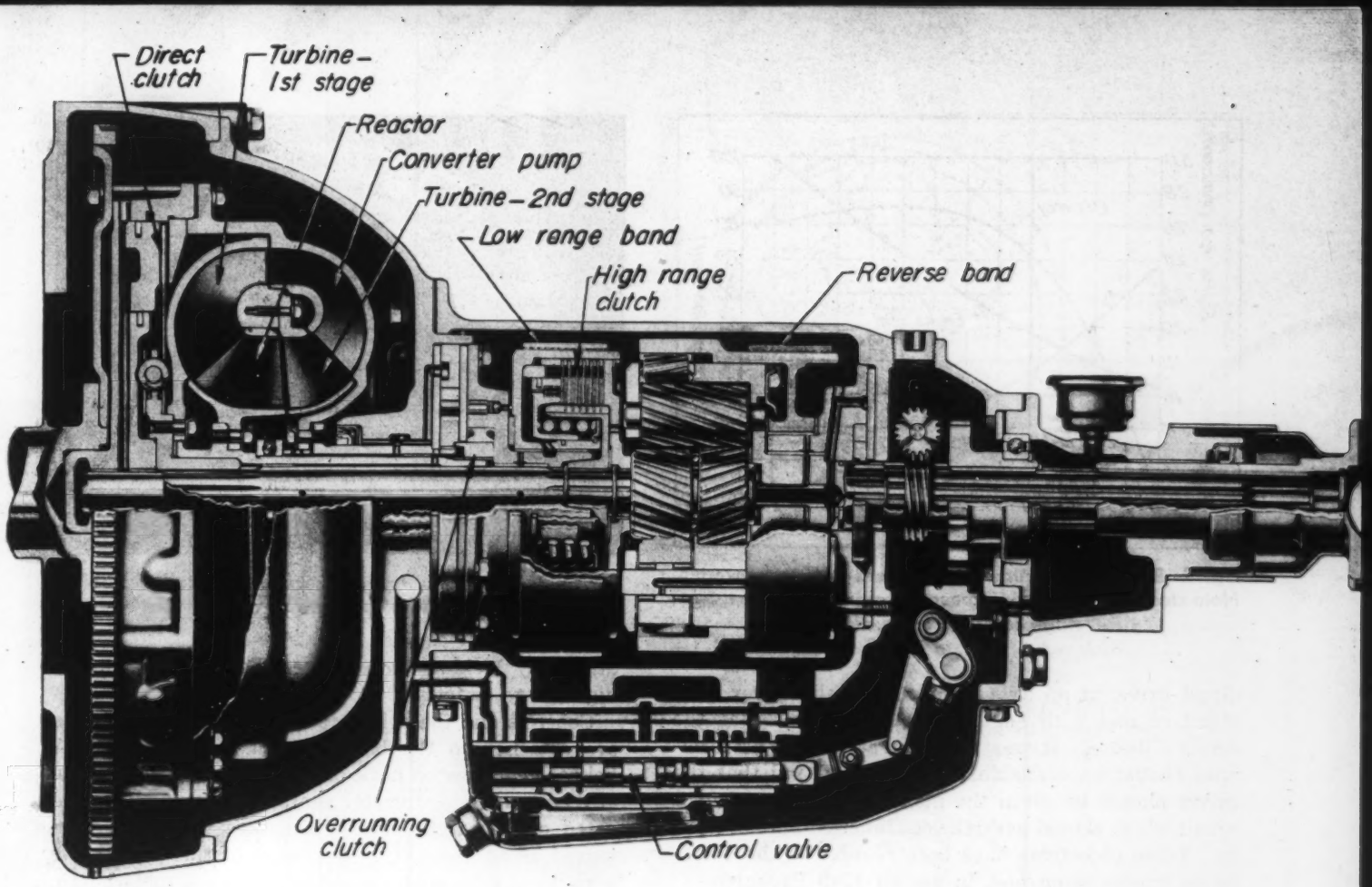


Fig. 3—Fine thread tolerances. Comparison of Class 2A and 2B unified and Class 1, 2 and 3 National Fine





Torque Converter Transmission

. . . utilizes automatic clutch to provide direct mechanical drive when not accelerating

By J. G. Vincent and Forest McFarland

Vice President of Engineering *Chief Engineer, Research Div.*

Packard Motor Car Co.

Detroit, Mich.

LIKE all other important motor car improvements, the design and development of the Packard automatic transmission has been brought about by engineering teamwork under sympathetic management rather than by any individual engineer. The ultimate goal in designing the Ultramatic drive was to give the car owner a smooth, reasonably quiet acceleration with no evidence of shifting even at final

Based on a paper presented at the summer meeting of the SAE in French Lick, Ind.

Fig. 1—Above—Sectional view of automatic transmission. When in converter operation, engine drives converter pump which is bolted to crankshaft-mounted flexible plate. Both turbines and direct clutch are attached to shaft extending back through unit to rear sun gear. Planetary gearing provides either high range, straight-through drive or low range, geared drive. When in direct drive, direct clutch couples converter pump assembly to output shaft, by-passing converter. Operation of planetary unit is the same as when drive is through torque converter. Linkage from control valve engages pawl in gear for parking

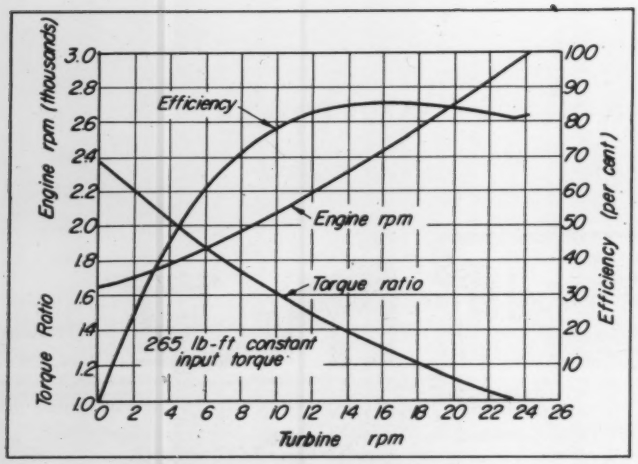


Fig. 2—Performance curves of Packard torque converter. Note steeply rising engine speed curve, resulting from two-stage turbine construction

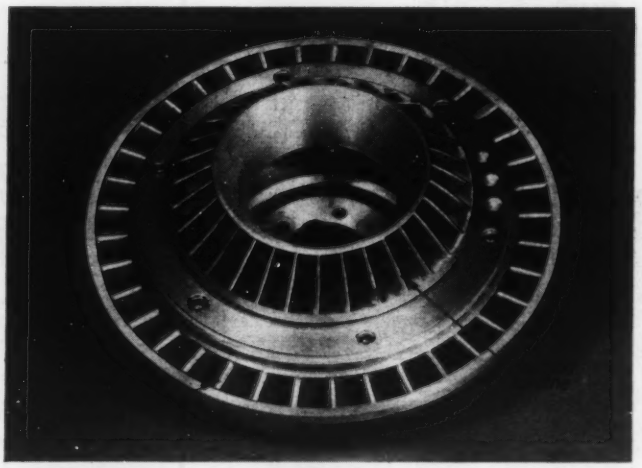


Fig. 3—Photograph of first and second stage turbines bolted together to rotate as a unit

direct drive, at an axle ratio numerically lower than standard and with engagement which occurs at the driver's desire. It was felt that additional performance should be available when required and that the driver should be given the maximum of control over a unit which should nevertheless function automatically. These objections have been realized in the Ultramatic transmission now in use on 1949 Packards.

GENERAL ARRANGEMENT: Shown in section in *Fig.* 1, the transmission consists of a torque converter with planetary gearing. Two clutches and two brakes are arranged to obtain a high range, straight-through drive and a low range, geared drive. Converter or direct mechanical drive operates in either range. Starting is through the torque converter in either range, with automatic shift into direct mechanical drive governed by car speed and throttle position. Converter operation can be obtained when in direct drive at any time in high or low range under top governed speed by "kicking down" the accelerator, as on overdrive cars. The two ranges and reverse are obtained by a clutch and brakes with no gear tooth engagement.

A flexible disk is mounted on the crankshaft and bolted to the direct drive clutch housing which, in turn, is attached to the converter pump that has a rear extension driving the front oil pump. The converter turbine, or driven member, is attached to a hub which also carries the direct clutch driven member and damper located just ahead of the converter turbine. The hub carrying these two members is splined to a shaft which is in turn splined to the rear sun gear of the planetary train. In addition this shaft carries a hub driving the plates of the high range clutch. The reactor is mounted on a sleeve which engages with a one-way sprag clutch mounted in the housing rear of the front pump.

In the planetary gearing double pinions mounted in a cage attached to the final driven shaft mesh with two sun gears and a ring gear. This planetary train provides an underdriven low range ratio of 1.82 by braking the forward sun gear, and a reverse ratio of 1.64 by braking the ring gear. Direct drive is obtained by locking the sun gears together with the high range clutch.

Controls and the cylinders for operating the brakes are attached to the bottom of the center case. A helical gear located back of the rear pump drives the governor and speedometer gears. The governor is located on the right side of the case and can be removed as an assembly. Rearward of the governor is a parking gear with an actuating sprag underneath.

First step in the converter development was the design and construction of a converter of the conventional three-unit type. Immediate drooping of the pump speed from the stall value, and the short span of the conversion range, immediately gave rise to an intensive study and development program. Characteristics desired were a reasonably low stall speed, a satisfactory stall torque, a sharply rising pump speed curve, and a turbine coupling point extended well out on the turbine speed curve. A reasonably high efficiency and a fair degree of quietness were also desired.

Analytical study and development work resulted in the form adopted, which has a performance pattern as shown in *Fig.* 2. It will be noted that all of the objects desired have been attained to a satisfactory degree. The type of pump speed curve shown is felt to be most pleasing to the driver since increase of engine speed with increase of car speed is not believed to be as noticeable as a high initial stall speed.

One of the problems in a development of this type is the fabrication of parts with sufficient speed. Experimental parts were made of stampings in our experimental shops with more speed than castings could be obtained. The production parts on the first model are aluminum castings, as original tooling and changes appear to be less of a problem than with the stamped design which appears interesting for high production.

DETAIL DESIGN OF UNITS: Referring again to *Fig.* 1, the direct clutch ahead of the converter engages the pump and housing assembly to the output driveshaft at the speed indicated by the controls. A clutch facing of cork has shown desirable friction characteristics. Engagement of this clutch while submerged

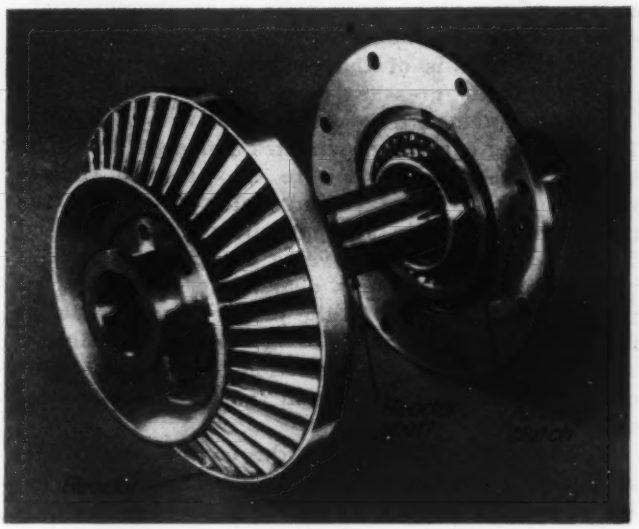


Fig. 4—Reactor member, located between turbine stages, showing over-running sprag type clutch

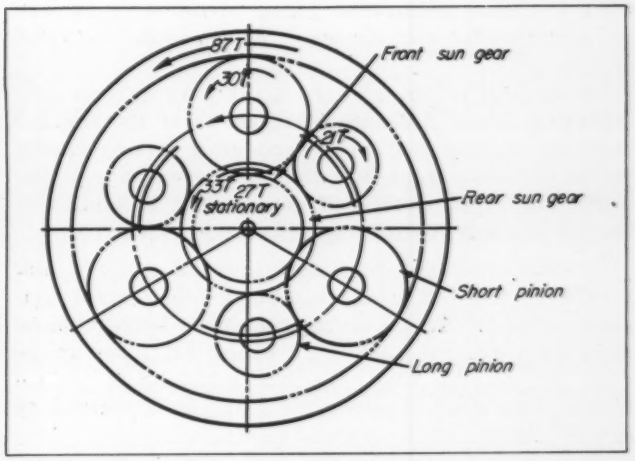
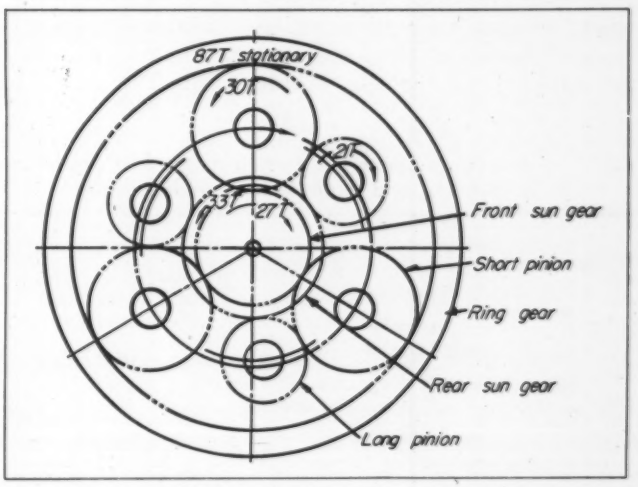


Fig. 5—Above—Planetary gearing in low range operation, viewed from rear. Low range brake band holds forward sun gear stationary, causing short pinions to "walk" around stationary sun gear at 1.82 to 1 reduction

Fig. 6—Below—Reverse operation of planetary gearing. Reverse band clamps ring gear, causing short pinions to "walk" around ring gear at 1.64 to 1 ratio



in oil has offered no serious difficulties. Disengagement was a problem solved by making the piston and driving plate one member, grooving the cork and taking advantage of converter charging pressure for release. It will be noted later, in the control diagram, that converter pressure is reduced to a low value when in direct drive to avoid reduction of capacity of the direct clutch.

The torque converter assembly is composed of three main members. The pump, which also serves as the housing for the assembly, is at the rear and is carried forward to fasten to the flexible disk on the crankshaft. The first turbine stage is nearest to the engine end and the smaller diameter second turbine stage, which is located nearest to the pump, is bolted to the first stage as shown in *Fig.* 3. The reaction member is located between the first and second turbine stages.

An overrunning clutch, *Fig.* 4, serves to lock the reaction member during the phase of torque multiplication, then releases it when the coupling point is reached. The convertor then acts as a coupling until the direct clutch engages. Therefore, the reaction member is free to rotate at all times except when torque multiplication is required.

Gearing is of the helical type of 20-degree pressure angle, 20-degree helix angle, 14.9 normal pitch with addendum height modified to balance the action, and with involute contact ratio of 1.4 and helical contact ratio of 1.8. In *Figs.* 5 and 6 are shown the operation of the planetary gearing for low range and reverse conditions.

The high range clutch is of conventional form using cork composition type of plates. The clutch has vent holes in the piston and an air bleed in the supporting member to avoid engagement in reverse. Testing on a fixture immediately indicated the need for these vents.

Pistons for actuating the low range and reverse brakes are of a so-called fast-acting type. The low range brake is operated by modulated pressure, *Fig.* 7, the reverse at 170 psi pressure. When oil is applied to operate the piston, it flows into the small center cylinder through the check valve, immediately forcing the small piston to take up the band clearance. An instant later, the large piston starts to move upward, forcing the oil above the piston out through a restricted vent. When the large piston has barely left its seat, the check valve in the center closes, trapping the oil in the small center cylinder, permitting the large piston to actuate the brake through the trapped oil and small piston. The restricted vent softens the action of the piston yet still keeps the acton fast. The method permits fast, soft action, enabling the driver to rock the car readily.

Brake bands are formed out of tubing with copper-brazed actuating lugs and lined with cemented semimetallic lining. Testing to date has indicated little trouble with the brazing procedure which greatly simplifies processing.

Rearward of the planetary gearing is the rear pump used for starting, and oil supply at higher speeds

when the front pump is at idling pressure. Next are the speedometer and governor, driven from the same driving gear.

To the rear of these gears is the parking gear and actuating sprag. Movement of the lever to the park position engages the sprag through a torsion spring which permits completing the shift even though the teeth abut. This method of engagement is similar to the reverse shift used for years on our overdrive.

CONTROLS: Method of applying the clutches and brakes is illustrated in the schematic control diagram, *Fig.* 7. The steering column indicator shows park (*P*), neutral (*N*), high range (*H*), low range (*L*), and reverse (*R*). Various positions of the selector lever locate the control valve in a position to cause oil flow to the proper actuating unit.

In neutral and park, oil is applied to the top of the low range and reverse pistons to provide full release. The high range clutch is vented. An electrical contact made by a switch actuated by the detent lever permits starting the engine in these positions only.

In high range, the control valve permits oil to actuate the high range clutch by modulated oil pressure proportional to throttle opening. Starting is, of course, in converter with the direct clutch engaging when the governor pressure, approximately proportional to speed, slightly exceeds the throttle pressure proportional to throttle opening, which results in shifting of the direct drive shift valve, thereby energizing the direct clutch.

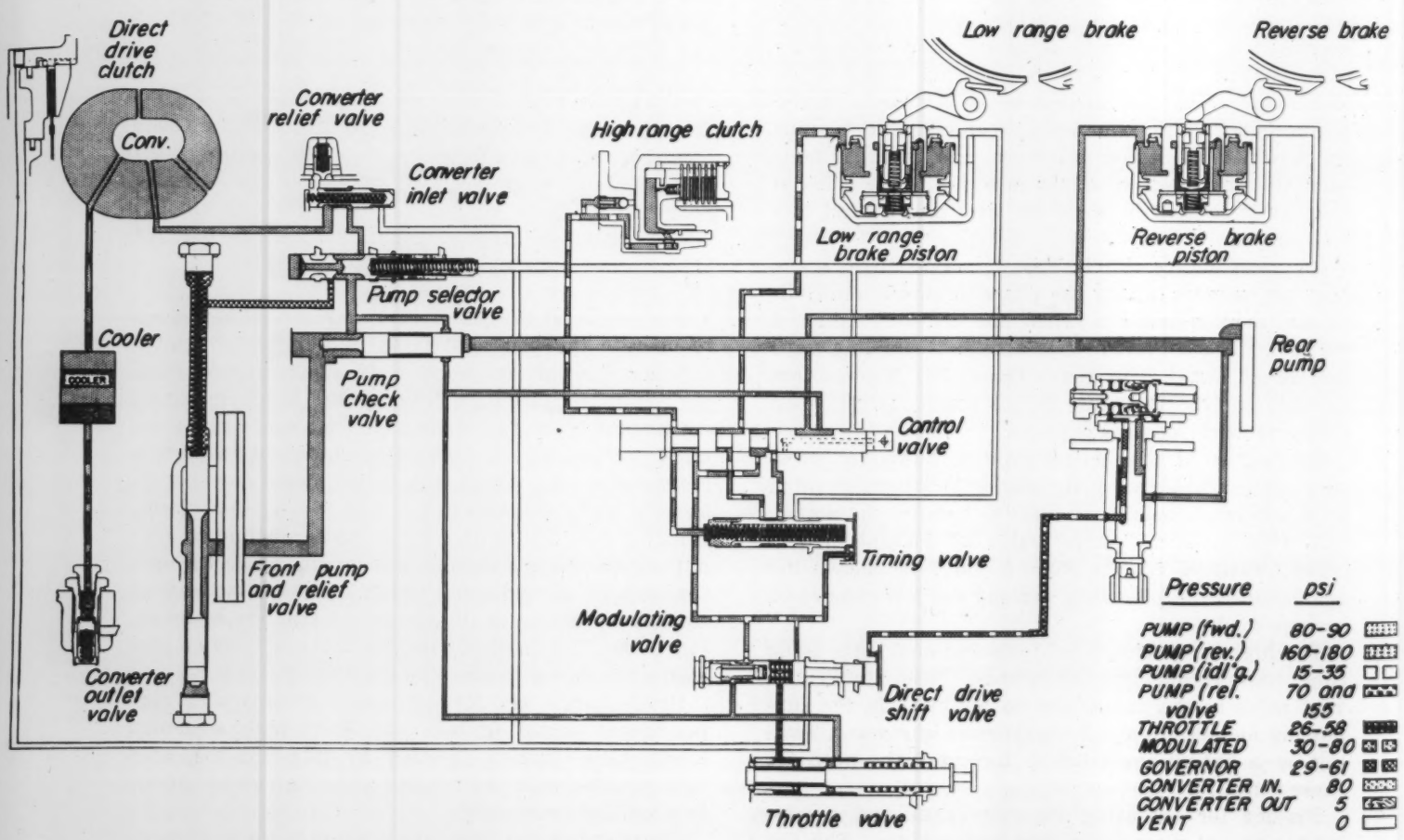
The governor is of the centrifugal type with the usual parabolic pressure curve sheared upward by addition of a spring to assist the governor weight. The resulting curve approximates a straight line. The valve at the opposite end to the pressure control valve is a centrifugal venting valve which cuts the governor pressure in at approximately 15 mph and definitely vents the shift valve at approximately 13 mph. This valve insures definite disengagement of the direct drive clutch at the proper time when coming to a stop. One point of interest in the throttle valve is that there is no reaction on the accelerator operating linkage even though the pressures are sizable.

In low range and reverse, the control valve energizes each piston respectively as previously described. Direct drive is obtained in low range as in high range, permitting extended hill climbing in either range without use of the converter. In low range, hill descent is also made with the engine positively connected to the gearing.

Shift from low to high range, made by the steering column lever, is accomplished by the timing valve. When the high range clutch pressure reaches a value indicating start of engagement of the clutch, the valve moves to the right, releasing the low range brake and positively disengaging it through oil ap-

(*Concluded on Page* 168)

Fig. 7—Schematic diagram illustrating method of applying both clutches and both brakes hydraulically



Film Pressures in Grease-Lubricated Sleeve Bearings

By Gunther Cohn
Research Engineer
The Franklin Institute
Philadelphia

and

Jess W. Oren
Research Engineer
Armstrong Cork Co.
Lancaster, Pa.

LUBRICATION analysis may be divided into three broad fields: Friction, which determines the power information; running position, which establishes the minimum film thickness; and pressure distribution, which defines the film outline.

Falling into the last division, the investigation discussed in this article was undertaken to determine whether a hydrodynamic pressure exists in a grease-lubricated journal bearing, and if so, to obtain its magnitude and distribution. These experimental results were obtained with a testing machine similar in principle and construction to that of S.A. and T. R. McKee.[1] However, in this design the fixture was made adaptable to lubrication by either oil or grease.

As *Fig.* 1 shows, a vertical steel shaft containing a ground journal one inch long is attached to a drill-press arbor through a flexible coupling and is aligned by two steady bearings. One of these is located in the top support bracket and the other in the base of the main frame of the fixture which is bolted to a special drill-press table. The bearing, a 300-degree babbitt-lined brass shell 2 inches long, is permitted to assume its own running position. In order to confine the lubricant, oil seals are fastened to its top and bottom. A single pressure tap hole, 3/32-inch in diameter, in the middle of the bearing surface, is used for all pressure traverses.

Circumferential traverses are made by rotating the bearing in a yoke ring. As the load is applied to the yoke its circumferential point of application remains fixed. A stop prevents the yoke from turning, and the bearing is held in the desired position by tightening a set screw. For ease of rotation, the bearing rests on the inner race of a Timken bearing, the outer race of which is held in a container provided with three leveling screws. An-

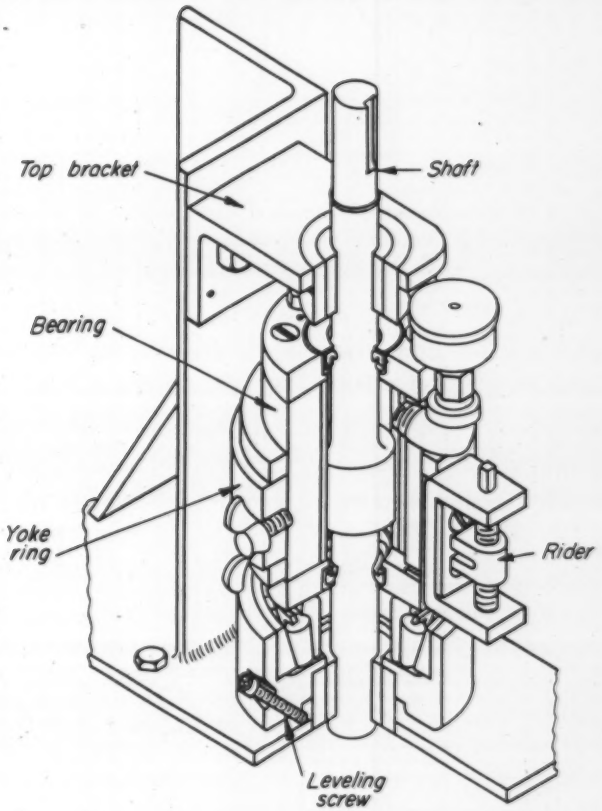
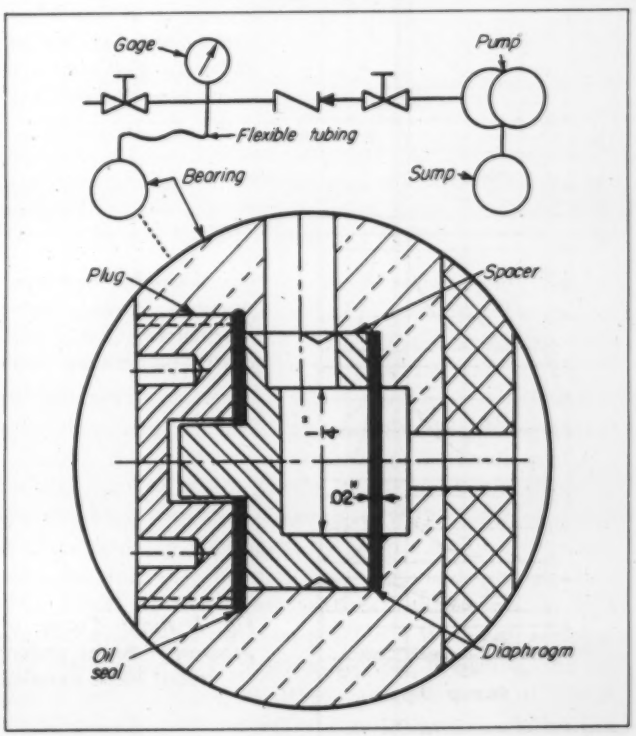


Fig. 1—Above—Cutaway drawing of machine used to test film pressures in grease-lubricated sleeve bearings

Fig. 2—Below—Schematic diagram of piping system used with testing machine, and enlarged cross section through tap-hole diaphragm



From a paper presented at the recent annual meeting of ASME in New York.

[1] References are listed at end of article.

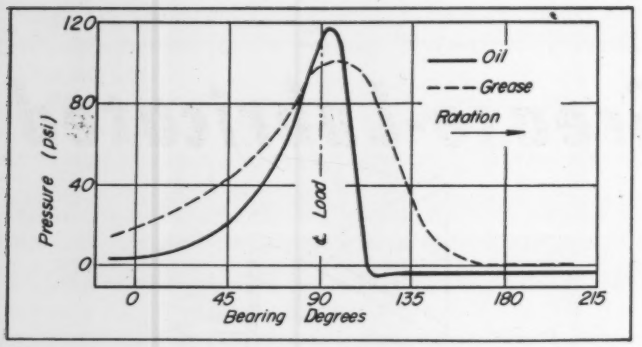


Fig. 3 — Circumferential pressure distribution in journal bearing at 0.5L location. Clearance is 0.0082-in. per in.; load, 40 psi; speed, 250 rpm

gular position of the bearing is shown by a pointer which moves over a scale engraved on the drill-press table.

Longitudinal traverses are made by moving the journal past the pressure tap hole in the bearing. This is accomplished by means of the drill-press feeding mechanism which can be locked by a set screw. An indicator fastened to the testing fixture points to a scale on the shaft which denotes the longitudinal position. The load is applied to a threaded rider which is moved axially by means of a lead screw held by a fork fastened to the yoke ring. By this means midpoint loading is achieved at all times so that an axial bearing motion is simulated. The lead screw is used as a micrometer to obtain a particular setting. When once it is set, the friction in the threads holds the rider in position.

Adjusted by a turnbuckle, a spring balance applies the load. The lubricant is fed through an ell fitting into the top of a deep, 60-degree channel which completes the bearing. Any excess grease is permitted to escape through a small vent at the bottom.

The pressure tap hole, at right angles to the axis of rotation, is plugged on the outside and an axial hole in the bearing shell connects with a gage through copper tubing, *Fig.* 2. This is the arrangement used for tests with oil. In early tests with grease, a vaseline plug was used to separate the lubricant from

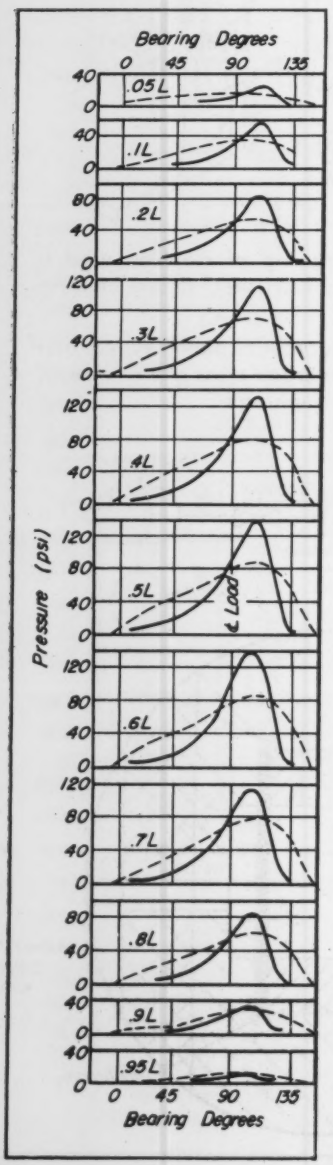
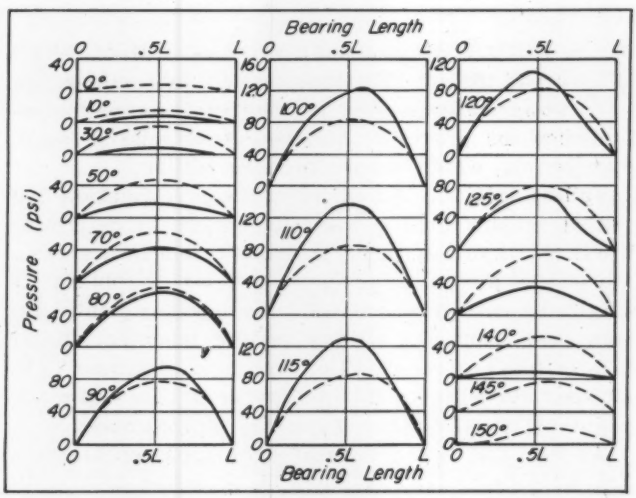


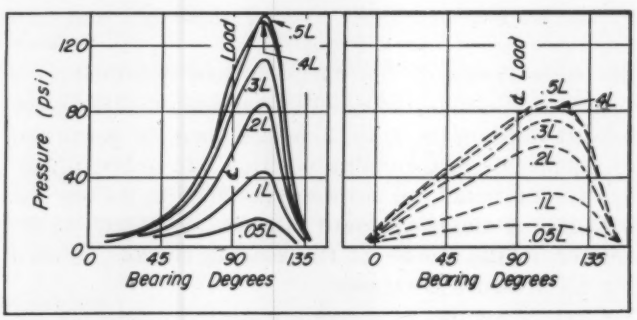
Fig. 4 — Left — Curves show circumferential pressure distribution for grease and oil-lubricated sleeve bearings at 250 rpm. Full lines are oil curves; dashed lines are grease curves

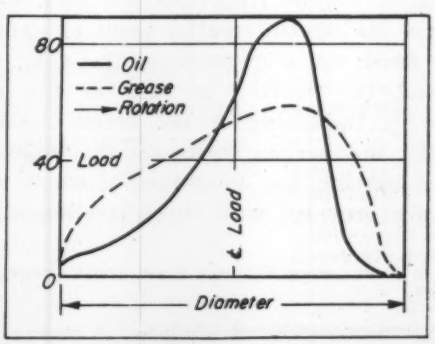
Fig. 5 — Right — Curves show longitudinal pressure distribution for grease and oil-lubricated sleeve bearings at 250 rpm. Full lines are oil curves; dashed lines are grease curves

Fig. 6—Right—Average-pressure curves; oil-lubrication, left, and grease-lubrication, right

Fig. 7—Right—Curves of integrated pressure. Areas under curves represent force exerted by film







the oil in the gage line. Later the tap hole was covered with a diaphragm with which steadier conditions were achieved. This necessitated a balanced-pressure system because of the small deflection of the diaphragm.

Of rayon-reinforced synthetic rubber, the diaphragm is 0.02-inch thick. It is cemented into the ¼-inch enlargement of the tap hole and held in place by a spacer. Finally, the hole is sealed and plugged. Flexible tubing, permitting bearing rotation, connects the axial hole to the stationary oil system, a series of valves, the measuring gage, a hand pump which supplies the back pressure, and an oil sump, *Fig.* 2.

Oil Tested for Comparison

Properties of the test lubricants are shown in TABLE I and the various test conditions are listed in TABLE II. Oil was tested in these experiments: (1) To establish the functioning of the fixture, and (2) to obtain a basis for comparison with the grease. For proper comparison, the oil chosen has very similar properties to that extracted from the grease, TABLE I. For testing oil, the machine was assembled without the grease cup and with the vent plugged. Oil was introduced into the bearing until its level was above the journal. The pressure gage was connected directly to the bearing. After the axial location of the journal and the point of application of the load were adjusted to the desired position, the machine was started and the load applied. Pressures were read at eleven longitudinal positions, 0.1-inch apart in the center of the bearing and 0.05-inch apart at the ends, designating the locations as 0.05*L*, 0.1*L*, 0.2*L*, and so forth. The circumferential intervals varied depending upon the shape of the expected curve; the steeper the curve, the smaller the intervals. Sufficient pressures were recorded to plot a distribution curve, thus covering about 200 degrees of bearing arc. Both circumferential and longitudinal changes in position could be made without stopping the machine.

As even slight misalignments of journal and bearing caused unsymmetrical longitudinal distribution, leveling screws were added to the bearing support to obtain correct alignment. An oil test was performed, using the method described, taking spot readings at the 0.2*L* and the 0.8*L* position. The bearing

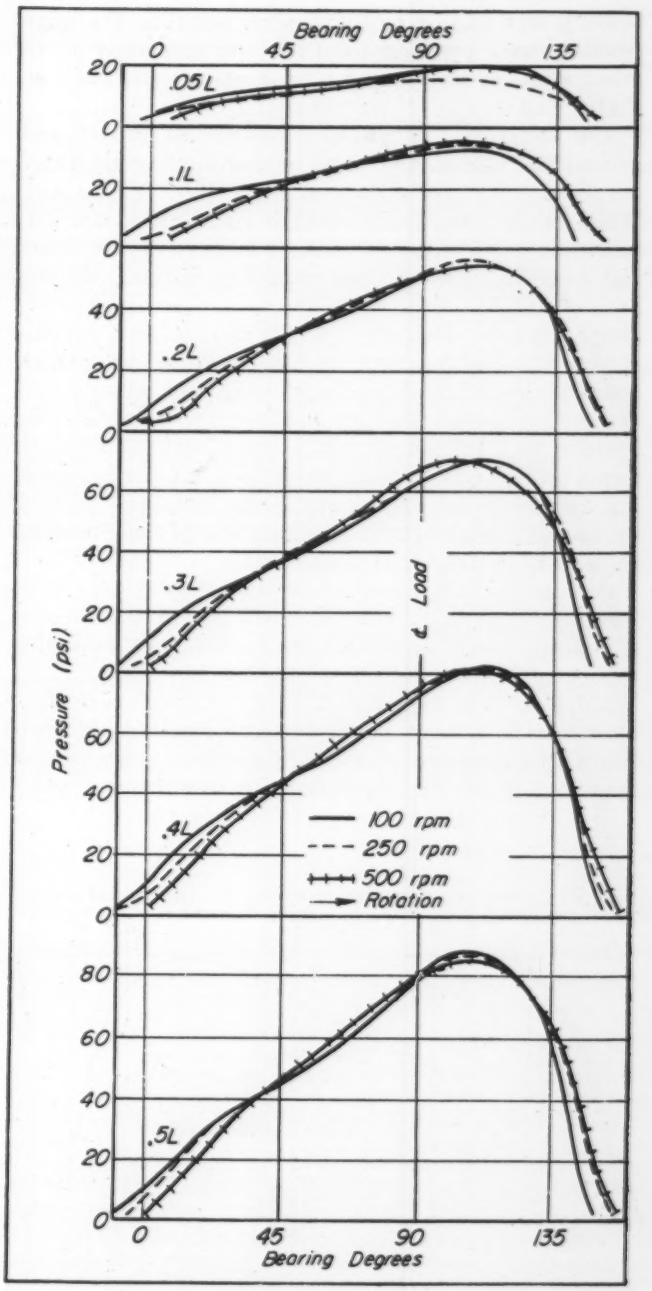


Fig. 8—Comparative circumferential pressure distribution in grease-lubricated sleeve bearing at three speeds. Clearance is 0.0071-in. per in.; load is 40 psi

was then tilted by means of the leveling screws until as nearly identical curves as possible were obtained for the two locations.

When operating with grease, the diaphragm was installed, the pressure system filled with oil, and the bearing packed with grease to prevent air pockets. The machine was then assembled with the grease cup in place and the vent open. Several cupfulls of grease were fed into the bearing and the load was applied after locations had been adjusted as for an oil test and the machine had been started. With the bearing in a circumferential position of low pressure, the oil system was pumped up to a back pressure of about 10 psi less than the expected film pressure. While the

TABLE I—Properties of Test Lubricants

Grease: NLGI No. 2 Grade Ball-and-Roller-Bearing Grease	
Calcium and sodium soap (per cent, approx.)	15
Mineral oil (per cent, approx.)	85
Penetration at 77 F (ASTM)	
Worked	268
Unworked	256
Dropping point (deg F)	296
Values of extracted mineral oil	
Kinematic viscosity (cs at 100 F)	52.8
(cs at 210 F)	6.54
Specific gravity at 60/60 deg F	0.9094
Pour point (deg F)	+20
Oil: 300-Sec Viscosity Paraffin Oil	
Kinematic viscosity (cs at 100 F)	52.7
(cs at 210 F)	6.54
Specific gravity at 60/60 deg F	0.8973
Pour point (deg F)	+20
Flash, C.O.C. (deg F)	413
Fire, C.O.C. (deg F)	463

bearing was turned to the desired position, the gage read the back pressure until the film surpassed it. In other respects the testing procedure was the same as that for oil.

The difference in physical properties of oil and grease necessitate the used of different methods of assuring a copious supply to the active bearing arc. When oil is used, the journal is submerged, and the lubricant flows into the leading portion of the bearing angle by gravity and capillary action. In the case of grease, the moving journal tears the adjacent film of grease from the feeding channel and carries it into the active bearing arc, creating an empty space between the journal and the grease supply. To assure a copious feed, it was necessary to fill this space with lubricant as fast as the journal carried it away. This was accomplished by continually pushing the grease past the moving surface of the journal by manual operation of the grease cup and exuding the excess grease through the vent.

Circumferential pressure distribution at the $0.5L$ location of an early test is shown in *Fig.* 3. This is a typical oil curve which checks with the fluid-film theory of a finite bearing and with the results found by McKee.[1] In the direction of rotation there is a slow rise to a large positive peak, then a rapid drop to a slight negative peak, thus establishing the proper functioning of the machine. A combination gage (-8 to $+20$ psi) was used to obtain the low points.

As shown in *Fig.* 3, grease develops a hydrodynamic film the pressure distribution of which is similar to that of the oil. This traverse was taken with a vaseline plug instead of the diaphragm and with mechanical alignment only, which accounts for the difference in circumferential location of the pressure peaks.

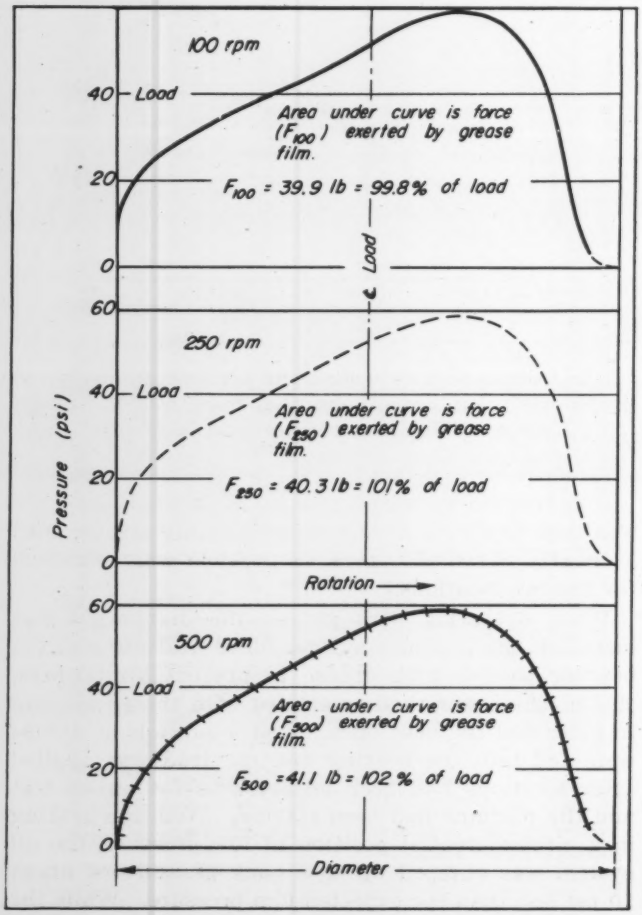
A complete comparative study of oil and grease at 250 rpm is shown in *Fig.* 4. Actual test points are plotted in the circumferential pressure curves, obtained by using the diaphragm back-pressure method under copious lubrication. Negative pressures were not obtained since only one gage (0 to 200 psi) was used throughout. It was felt that this would not detract from the value of the results, as the investigation is primarily a test of grease. All curves rise slowly to a peak at the "off" side of the line of application of the load and then fall off more rapidly. The grease curves are lower and extend over a greater arc but are similar in shape to the oil curves, namely, skewed sine curves. Maximum pressure with oil is about 3½ times the applied load, or about 2¼ times the load with grease at a bearing temperature of approximately 75 F. All pressure peaks fall at an angle of about 110 degrees, proving proper alignment of journal and bearing.

TABLE II—Test Conditions

(Journal: nominal length = 1 in.; nominal diameter = 1 in.)

Test No.	Speed, (rpm)	Diametral Clearance (in. per in.)	Load, (psi)	Lubricant (see Table I)
1	250	0.0082	40	Oil
2	250	0.0082	40	Grease
3	250	0.0071	40	Oil
4	100	0.0071	40	Grease
5	250	0.0071	40	Grease
6	500	0.0071	40	Grease

Fig. 9—Curves of integrated pressure for grease-lubricated sleeve bearing. Clearance is 0.0071-in. per in.



As shown in *Fig.* 4, the pressure peaks fall at an angle of about 110 degrees, proving proper alignment of journal and bearing.

The curves of *Fig.* 5 are the cross-plots against bearing length L, chosen at various intervals which depended upon the rate of change of curvature of the pressure-distribution plots. The most striking difference between the oil and the grease may be observed at the position at right angles to the line of action of the load where the grease curves are much higher, indicating that grease has less end leakage than oil. Arrangement of the longitudinal curves about the median plane of the journal ($0.5L$) can be seen in the curves of average pressure in *Fig.* 6. Here the $0.1L$ curve is plotted from the average points of the $0.1L$ and $0.9L$ location, and so forth.

For a check with the applied load the curves of *Fig.* 7 were plotted by integrating the longitudinal curves and plotting the mean pressure thus obtained at the angular positions projected on the diameter at right angles to the line of action of the load. In the case of grease there is a good correlation, but in the case of oil the value obtained by integrating is low (88 per cent of the applied load). This is due to the failure to measure the negative pressure which helps carry the load and the inability of the gage to

(Concluded on Page 172)

Panel Type Air Filters

Their selection and application in machines

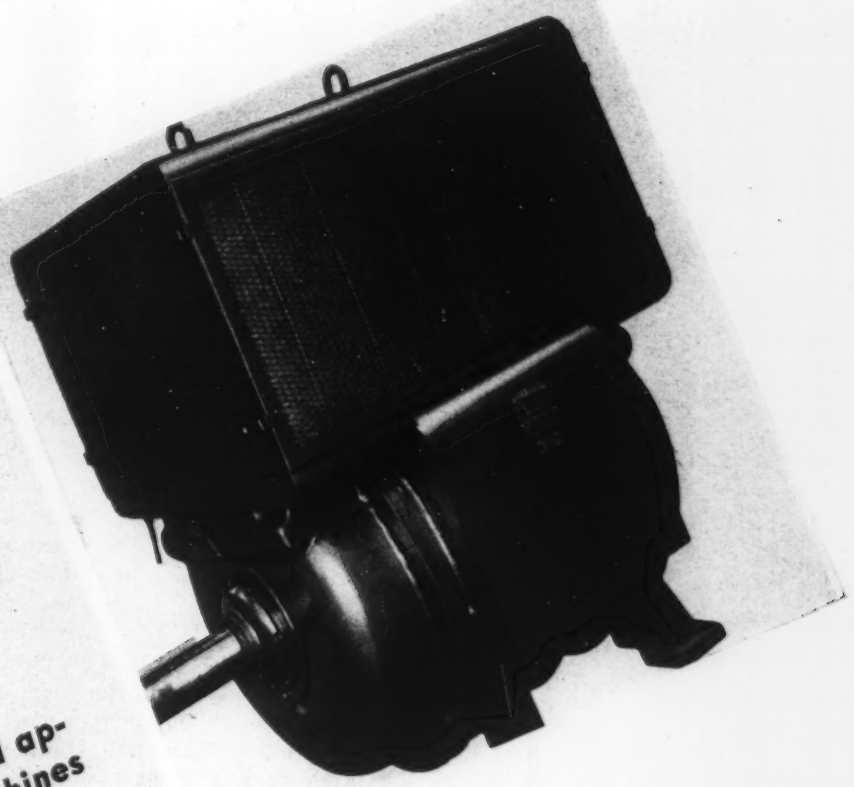


Fig. 1—Large a-c motor, designed for use on punch and forging presses, with replaceable type filters to assure a clean supply of cooling air

By Charles R. Sutherland

Head Design Engineer, Small Motor Division
Reliance Electric & Engineering Co.
Cleveland, Ohio

Fig. 2—Cross section of a permanent type filter showing application of various filtering mediums

COINCIDENT with the gradual development of high-speed machinery, there evolved a need for increasing volumes of clean air for cooling electric motors, *Fig.* 1, and other equipment. The air required filtering not only to protect the equipment but in some instances, such as with processes involving grinding, to protect the atmosphere of the surrounding area from extensive pollution. Insofar as electrical equipment is concerned, the availability of filtered air for motors, generators and controls has made installations possible which otherwise would have had to be handled in a much less effective fashion.

Atmospheric dust is found everywhere. Not many years ago the problem of dust was considered a necessary evil and not much was done about it. With the rapidly increasing developments in precision machinery, however, the problem of atmospheric dust has required more and more consideration. In industry, the protection of high-speed machinery, accurate tools and precision equipment against dust and dirt contamination has become extremely important.

Ordinarily air is considered a free commodity; however, air that is free of all dust particles and other contamination is expensive. Because of the problems and cost attendant to maintaining all the air in a plant free from contamination, the practical solution has proved to be filtering of the air for each individual installation. The filtering of air is not entirely new, and was first generally employed in connection with the purifying of air used in public buildings. Today, industry spends millions of dollars every year to protect its equipment against atmospheric pollution and process by-product contaminants. Thus, it is increasingly important that the designer proper-

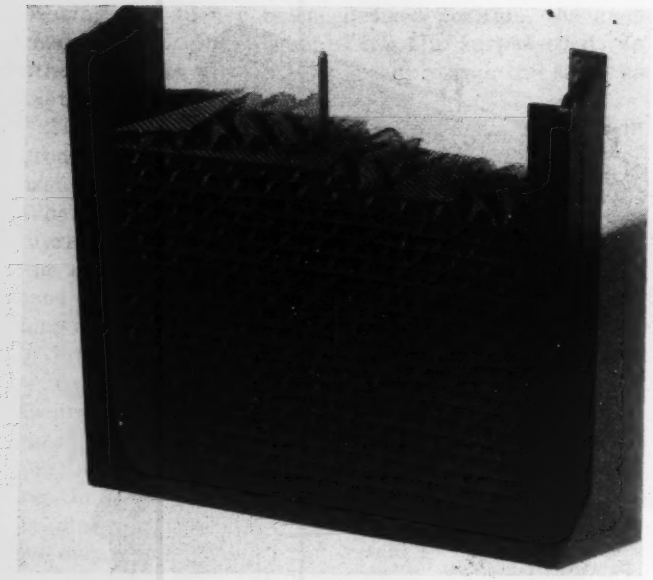


Fig. 3—Screen type filter with section exposed to show arrangement of screens

ly consider the matter of filter application in all types of machinery to insure longer life and more efficient operation. The discussion that follows will treat mainly with the use of panel type filters as they may be applied to machines as built-in units.

IMPURITIES IN AIR: Innumerable impurities are present in the air in the form of vapors, dust, smoke, or entrained liquids. Generally speaking, the problems of filtering air for machinery can be considered from the standpoint of:

1. Atmospheric dust
2. Atmospheric water-entrained particles
3. Process generated dust
4. Process generated liquid-entrained particles
5. Process generated miscellaneous particles.

Atmospheric dust consists of particles of sand, ashes, soot, fibers, chemicals, animal and vegetable matter together with bacteria and other micro-organisms. Dust is regarded as a foreign particle of one micron or larger. A micron is a unit of microscopic measurement for objects smaller than 0.01-mm and is equal to 0.001-mm or 0.00004-inch. The smallest particle visible to the human eye measures between 10 and 20 microns. Particles smaller than 10 microns are a health hazard if present in any great quantities or if of a noxious variety. However, for industrial equipment, particles of 10 microns or larger are injurious as well as a nuisance and can be successfully eliminated by proper application of air filters.

TYPES OF FILTERS: Generally, there are two types of panel filters on the market. They are the (1) viscous impingement type, and (2) dry type. Other filters of a nonpanel type, not so readily suitable for built-in machine installation are (1) water and oil washers, (2) gravity and centrifugal separators, (3) thermal precipitators and (4) electrical precipitators.

Viscous impingement type filters utilize the principle of driving the dust-laden air through a tortuous path. The dust, having a greater mass, will tend to travel in a straight line. As such it is impinged against a viscous-coated surface and firmly held by adhesion while the clean air passes on. It is evident that for a filter of this type the velocities of the air must be sufficiently high to drive the dust against the adhesive-coated surfaces. If, on the other hand, the velocities are too high, the amount of dust particles collected in any given area will be too great and will build up increased resistance to air flow.

Fig. 4—View showing compactness of filtering medium used in a typical replaceable unit

Dry filters depend on the straining or screening effect of the medium contained in the filter. Since the filtering depends upon the straining action, the mediums used in dry type filters must be of a fine and somewhat dense material such as felt. In order to avoid excessive resistance, the velocity of the air passing through the filter must be kept well below 50 fpm. Dry type filters readily absorb vapors and moisture, thereby increasing the resistance to air flow.

FILTER MEDIUMS AND CONSTRUCTION: Filters may be made of many materials providing they afford the air a sufficiently tortuous path to break up the flow and trap the particles by impingement or straining action. As explained previously, the filters can be of the viscous impingement or dry types. It does not follow that the material used within the filter predicates the type. In some instances, a material used by one manufacturer may be designed as a dry type filter and the same material used by another manufacturer may be used as an impingement type. In many

TABLE I—**Panel Filter Mediums and Types**

Material	Type	
	Viscous	Dry
Glass Fiber	X	X
Screen (perpendicular to flow of air)	X	
Screen (parallel to flow of air)	X	
Knitted wire mesh	X	
Expanded fiber	X	X
Expanded aluminum foil	X	
Animal hair	X	X
Felt		X
Fabric-cloth		X
Cellulose		X

cases a filter may contain a combination of mediums in various arrangements. For purposes of illustrating the wide variation in materials and their uses, TABLE I lists some of the more common mediums. Cross sections of typical filters are shown in *Figs.* 2, 3 and 4.

Another factor which differentiates the kinds of filters is whether they are considered as a "permanent" or "throw-away" type. There is no doubt that the so-called permanent filters are more substantial and expensive than the throw-away type. In fact, one of the first questions the designer must settle is which of these basic filter types he will use. The economics of the question enter in this manner: A cleanable or permanent type filter is suitable for machines or installations where the user will have to service a great number of filters. In such cases the user may install cleaning equipment or have the filters cleaned. Throw away filters, in the above case, would represent too great a cost every time the filters needed replacement. On the other hand, where a single machine is being used and filters requiring cleaning are few and cleanings infrequent, then it is logical to design such machines with throw-away filters.

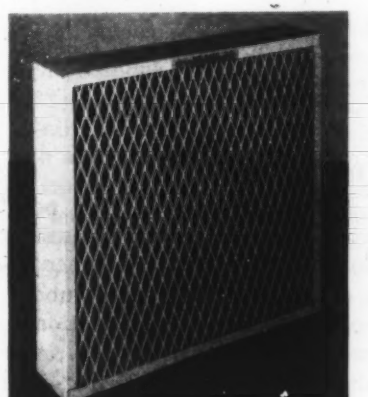
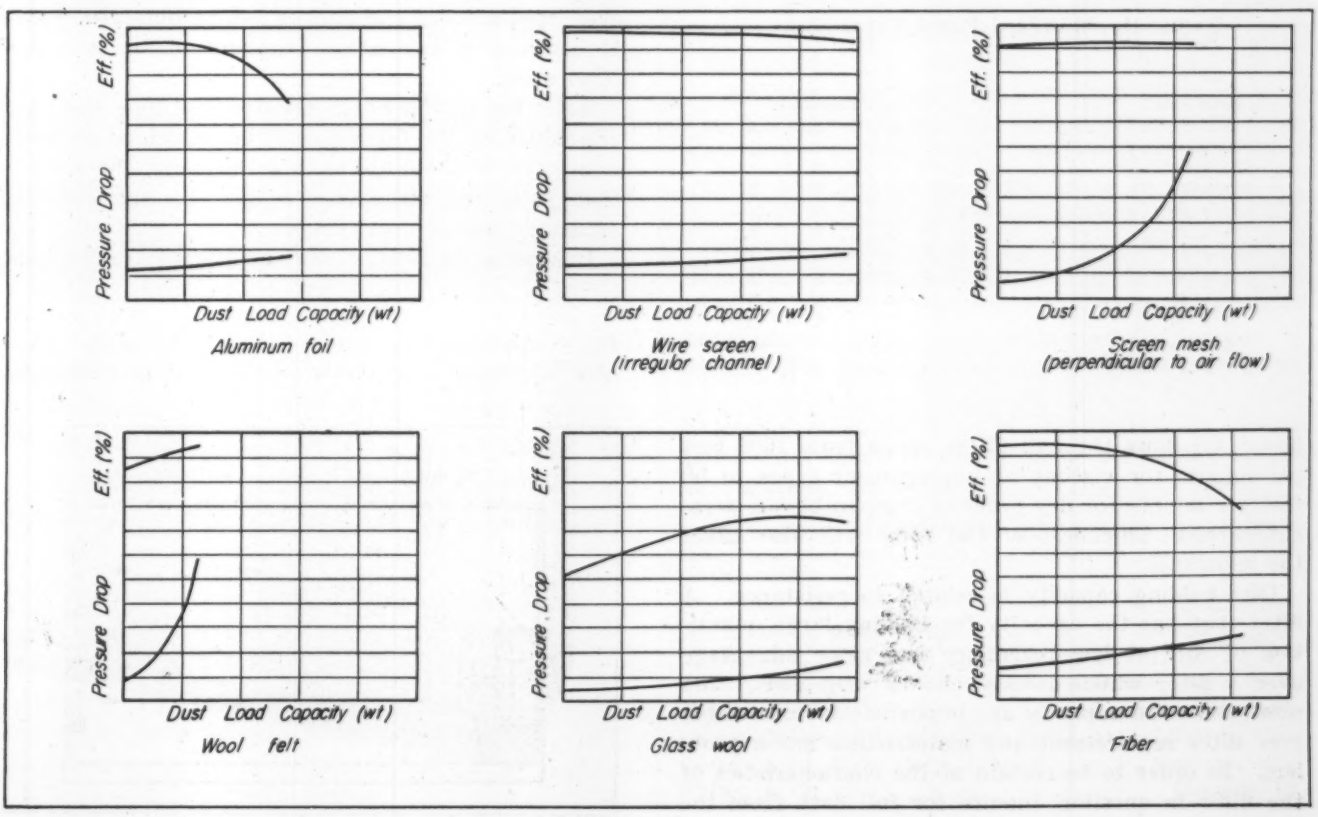


Fig. 5 — Left — Filter panel showing heavy expanded metal guard sometimes employed to prevent mechanical abuse

Fig. 6—Below—Curves for typical filter mediums showing the general trend of pressure drop, efficiency and dust holding capacity

FILTER CONSTRUCTION DETAILS: For machine applications, filters should be securely fastened into their holding frames. Some filter manufacturers offer special frames for mounting filters. The permanent all-metal type filters usually have secure means of fastening the filters into the retaining frames. Often rubber or felt seals are used between the filter and the holding frame to prevent air leakage around the edges of the filters. In the throw-away type, the seal at the edge of the filters is made by wedging the edges of the filter into the retaining holder. Placing a suitable grill over the filter keeps it in place. This form of edge sealing is very acceptable in many applications. Some filters are provided with snap inserts and handles to facilitate removal. In *Fig.* 5 the use of heavy gauge expanded metal to protect a filter panel is shown.

FILTER RATINGS: It is rather difficult to state specifically what each type of filter will do in terms of performance. It is interesting to note that all filters have three characteristics and the summation of these characteristics determines the total practical performance of the filter. The three basic characteristics are: Efficiency, resistance to air flow, and dirt holding capacity. At best each make of filter represents a compromise between the three qualities. Each of these factors has a counteracting effect on the other. If a filter is too efficient it will in all probability have high resistance to air flow and also have



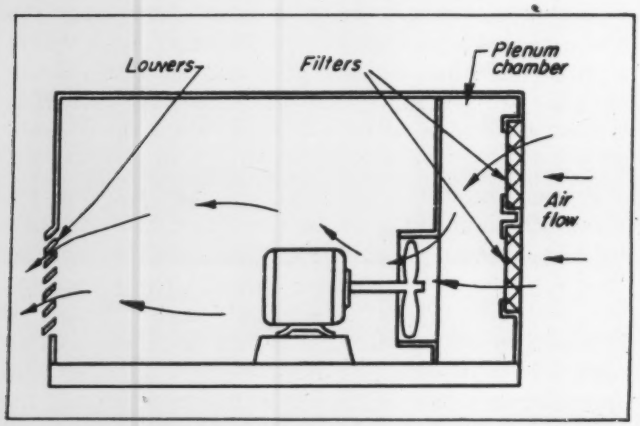


Fig. 7—Plan for introduction of air by means of a plenum chamber creates a positive pressure eliminating the need for any special sealing precautions

low dirt holding capacity. The inverse of the situation is also true.

The efficiency of a filter is the measure of dust particle elimination after the air has passed through the filter. Efficiencies may range from 60 per cent to as high as 98 per cent on panel type air filters. Filters usually have a characteristic efficiency curve depending on the medium and construction. Some have low initial efficiencies and as their resistance increases, their efficiencies rise. On other filters the inverse is true. The curves, shown in *Fig.* 6, illustrate the direction of values of pressure drop, efficiency and dust holding capacity.

Resistance is a measure of the pressure drop within or across a filter. Filters with a high resistance may be efficient as far as dirt removal is concerned, but it may be with the penalty of a restricted air flow. Air flows through filters range from 1000 feet per minute for viscous or impingement types to 50 feet per minute for dry types at comparable air pressure drops. Thickness of the filter will also affect the resistance.

Dirt holding capacity is related to resistance. A filter that has the capacity for holding large quantities of dirt at low resistance has some advantage over a filter which quickly chokes with dirt. Dirt absorption and capacity are important factors whenever filter replacement and maintenance are a problem. In order to be certain of the characteristics of the filter in question, inquire for full data from the manufacturer of the filter in question.

TABLE II—**Standard Panel Filter Sizes**

(inches)

Filter Size	Thickness		
	1	2	4
10 x 10*		X	
10 x 20		X	X
16 x 16*		X	
16 x 20	X	X	X
16 x 25	X	X	X
20 x 20	X	X	X
20 x 25	X	X	X
20 x 30		X	X

* Not common.

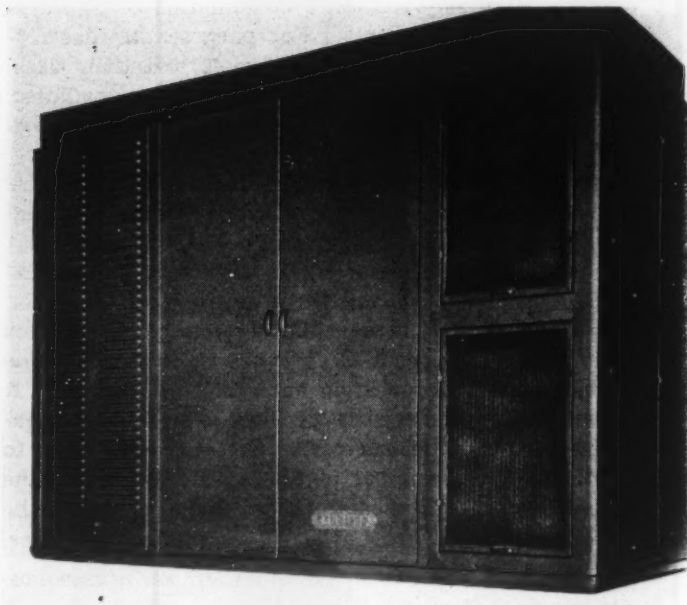


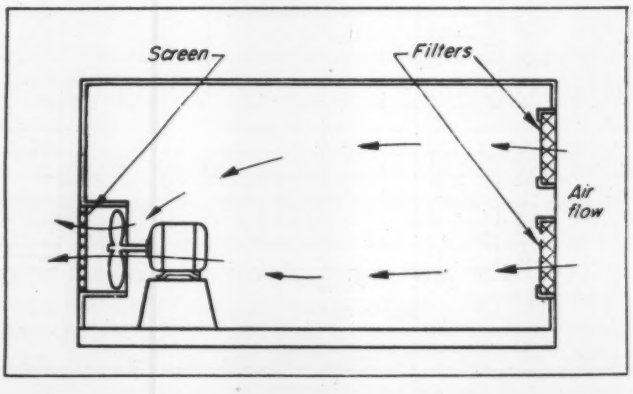
*Fig. 8—Large housing for a Reliance V*S control having permanent type filters mounted in the plenum chamber as in the design shown in Fig. 7*

USE OF FILTERS IN MACHINES: Up to this point not much has been mentioned concerning the use of filters in machines. However, the basic fundamentals have been outlined in order to permit a full understanding of the functions of a filter. Application to machines requires some further consideration. The volume of air to be filtered should be anticipated or calculated. Referring the air volume to a filter catalog, the filter size can be easily determined. It is most economical to select a standard size filter; however, special sizes and shapes can be obtained. TABLE II contains a tabulation of some of the standard filter sizes.

After the size has been selected, the type and characteristics of the filter should be examined to determine if it is the most suitable filter for the application, from the standpoint of dirt holding capacity, efficiency, and pressure drop.

It is often desirable to mount filters in such a posi-

Fig. 9—Alternate plan to that in Fig. 7, this design is suitable for many applications where a fairly well sealed space is available



tion that the air is induced into the unit by means of a plenum chamber, *Fig.* 7. This plan provides a machine cubicle that can be under positive pressure at all times and does not require further sealing. *Fig.* 8 shows the large housing of a Reliance adjustable-speed V-S drive control unit employing such a plenum chamber. An alternate scheme which is more economical to construct but in which a negative pressure results is shown in *Fig.* 9. Sealing may be more critical in such an installation and should not be overlooked. A unit employing this simpler plan is illustrated in *Fig.* 10. This design is suitable for many special machine applications. It is always highly desirable that filters be placed above the floor level to protect the filter from mechanical abuse and to raise it somewhat above the dirt zone.

Conditions May Require Filters

SPECIAL APPLICATIONS: The fact that a machine requires filtered air often indicates unusual working conditions. Frequently, the problem of filtering is encountered with atmospheres which are common in machine shops, *Fig.* 11. Permanent filters are available for the purpose of removing the oil vapors from the air. Usually these filters are made with a finer mesh and are also designed with a means of draining the excess trapped oil. A few throw-away filters are also made for removing oil in air.

In many process plants fire hazards such as sparks are prevalent. An example of this would be a forging plant. Some electrical equipment is protected against dirt and scale by use of filters, *Fig.* 1. Precautions must be taken that the filters do not ignite due to falling sparks and high air flow. It has been known that permanent metal filters have caught fire from a small spark because of the fanning action and oil impurities present.

*Fig. 10—Small Reliance V*S control unit utilizing the scheme shown in Fig. 9. Use of filters has broadened the applications for this equipment by permitting it to be brought closer to the process machinery*

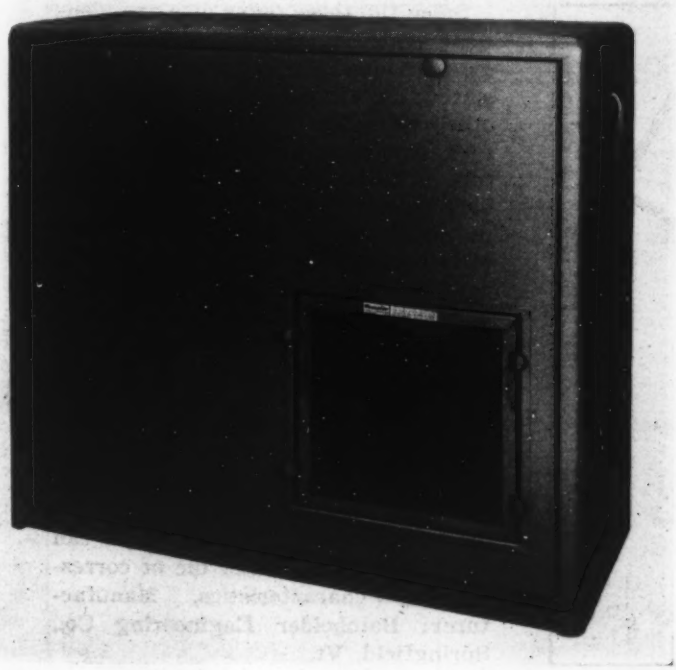


Fig. 11 — In this machine a filter is used to protect the surrounding atmosphere against pollution by grinding dusts

Other considerations to be made in applying filters are the problems associated with extreme shock which may tend to loosen or pack down the filter medium. Some machines may require a filter that is special in thickness or shape. Quantity requirements may predicate the use of a special size and in some cases there may be a cost saving.

MAINTENANCE: Each filter manufacturer publishes technical literature on how to obtain the longest life from a filter. As was pointed out earlier, permanent type filters require cleaning. Proper maintenance procedure instructs the operator to tap out the excessive dirt and clean the filter by dipping into a suitable adhesive. In some cases special adhesives are made for smog or other unusual atmospheric conditions. These special adhesives aid in cleaning the filters.

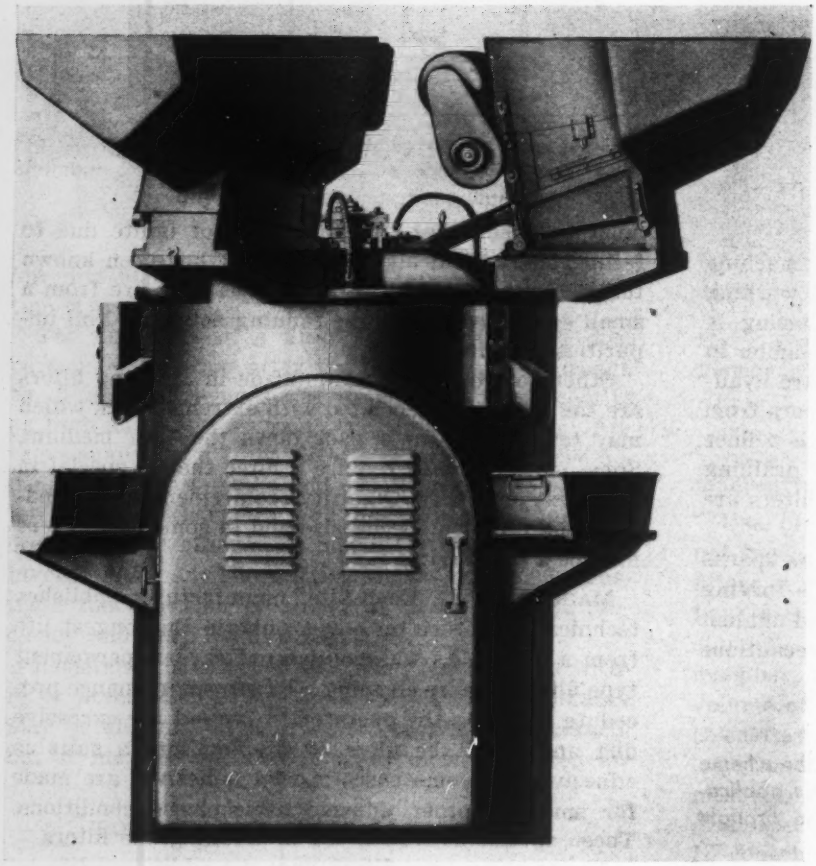
Throw-away type filters may get additional life by a restocking program. Four one-inch filters may be installed back-to-back. During maintenance the outer pack is thrown away and a new pack is pushed in from behind. Another variation is to remove the outer pack, tap out the dirt and replace it in the back.

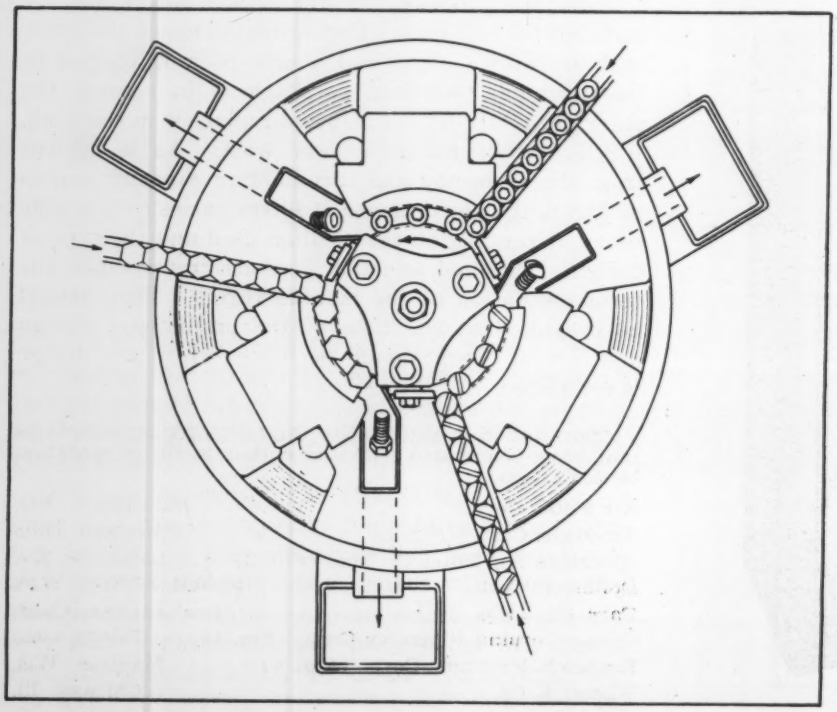
Selection of filters is very wide. As is evident from the efficiency and dirt holding capacity curves of *Fig.* 6, the performance of filters varies over a wide range, depending on the medium used and the type of design. The final selection depends greatly upon the recommendation of the manufacturers. They should be consulted at the time of the preliminary design and a final check should be made before the design is completed.

Appreciation is extended to the following organizations that have cooperated with the author in the preparation of this article:

Air Filter Corp. ..... Milwaukee, Wis.
Air-Maze Corp. (*Fig.* 5) ..... Cleveland, Ohio
American Air Filter Co. Inc. (*Fig.* 2) .... Louisville, Ky.
Dollinger Corp. ..... Rochester, New York
Farr Co. (*Fig.* 3) ..... Los Angeles, Calif.
Owens-Corning Fiberglas Corp. (*Fig.* 11) .. Toledo, Ohio
Research Products Corp. (*Fig.* 4) ..... Madison, Wis.
Wilson & Co. ..... Chicago, Ill.

DESIGNS OF THE





Planetary Thread Roller Utilizes Triple Dies

SECRET of the high productive capacity of the planetary thread roller shown in the accompanying illustration, left, is the system of using one externally threaded, continuously rotating, cylindrical inner die and three internally threaded, stationary, external segment dies. The drawing, left below, shows how blanks having three different types of heads can be rolled simultaneously, if desired, and dropped into separate work bins or pans.

Three independent automatic feeds deliver blanks to each of the outer dies, where starter fingers introduce the blanks to the starting ends of the outer dies. When the screws have rolled between the dies a distance of about half the outer die length, another set of three blanks is introduced between rolling and stationary dies. At least six screws are always being rolled at any given instant.

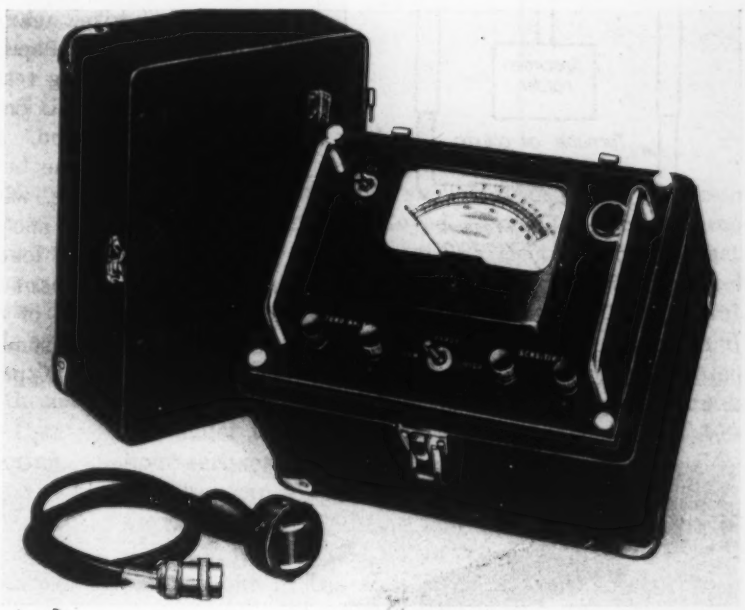
Since the three outer dies are identical, matching the cylindrical inner die with one of the outer dies, when setting up, automatically matches the other two dies. Slip clutches in the feed systems prevent damage in the case of jamming. Production rate is 750 headed, 4-48 to ¼-18 machine or cap screws per hour. When rolling preheat-treated stock, a single lobe cam is substituted for the double lobe cam on the starter finger mechanism, and blanks are started through the dies half as often. The thread roller is capable of Class 3 thread accuracy with a lead error or less than 0.0002-inch per inch. One or two dies can be replaced if damaged, without replacing the entire set. Any inner die with correct pitch and lead can be used with any outer die of corresponding characteristics. Manufacturer: Batchelder Engineering Co., Springfield, Vt.

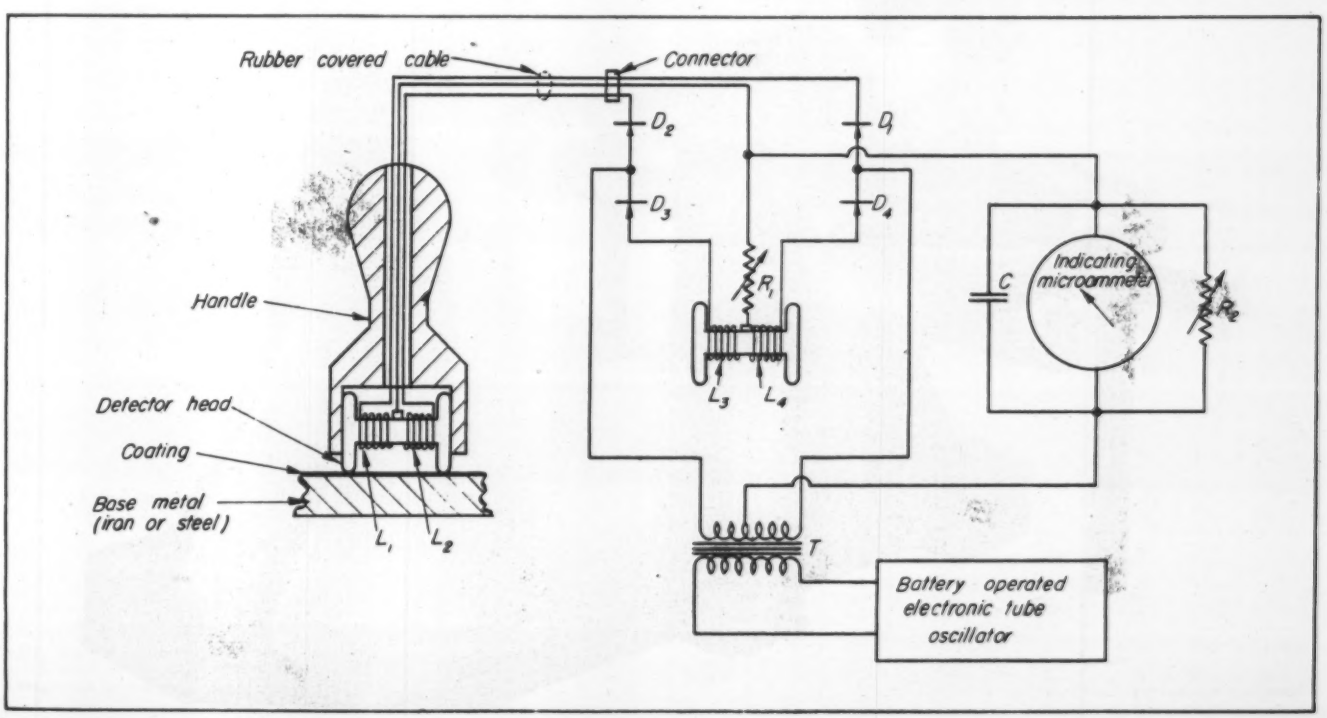
E MONTH

Instrument Measures By Reluctance

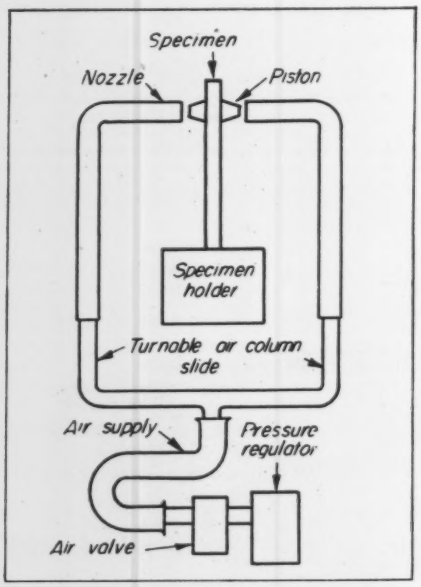
CHANGES in the reluctance of a magnetic circuit are utlized in the instrument shown at right to measure the thickness of nonmagnetic materials on an iron or steel base. At zero coating thickness the magnetic circuit consists essentially of low reluctance iron in the detector head and the base material. Any separation between them by a nonmagnetic material will decrease the impedance of the coil in the detector head (L_1 and L_2 in the schematic drawing, below). This coil is connected into a bridge circuit and excited by an alternating current. The bridge is balanced at maximum impedence which occurs when the coating thickness is zero, and as the detector head is separated from the base material the bridge becomes unbalanced and causes current to flow through the indicating microammeter. Degree of unbalance, shown by the deflection of the instrument, is a measure of the separation between the gage head and the base material and can therefore be used to measure the thickness of the coating.

Two instrument scales cover the ranges of zero to 0.012-inch, and from 0.010-inch up. Scales are calibrated by adjusting to scale zero with the detector head on bare metal, and to full-scale deflection with a 0.012-inch thickness specimen inserted between the metal and the head. Small changes in curvature and thickness of the base metal have little effect





on the calibration. If the instrument is to be used on pipes it is necessary to first calibrate on the pipe using the procedure given before making any measurements. Measurements are made without damage to the coating, permitting use with paints, metal plating, etc. Manufacturer: Branson Instruments Inc., Stamford, Conn.

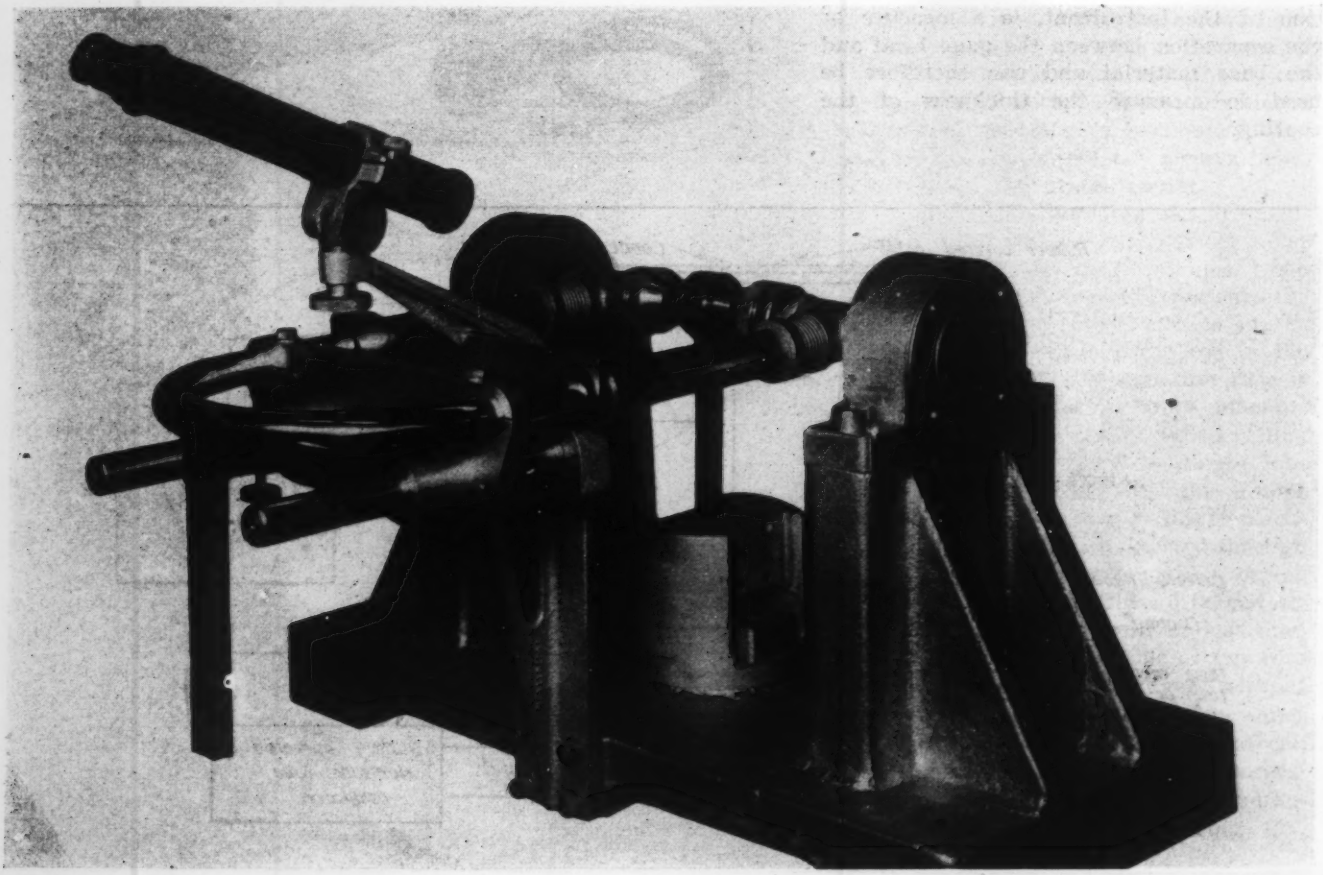


Fatigue Tester Driven Pneumatically

TUNABLE air column that can be adjusted to the natural frequency of a test specimen is used in the machine, below, for accelerated fatigue testing by reverse bending. A relatively small air supply is required by the pneumatically operated tester since the air impulses on the specimen are amplified by operating at the natural or resonant frequency of the part being tested.

In operation, the test specimen or finished part is clamped in a holder and two small pistons are fastened to the free end of the part. Of the seven "trombones" used to vary the frequency of the tester, the one having a frequency range covering the approximate resonant frequency of the specimen is installed in the tester. Two nozzles on the ends of the air column (see schematic diagram, left) are adjusted for a small clearance with the pistons on the test part. When a pulsating air supply is turned on, the specimen starts to vibrate at its resonant frequency. The pneumatic column is then tuned to the resonant frequency that gives maximum displacement of the specimen; i.e., when both air column and specimen are at the same frequency.

Samples having resonant frequencies of 50 to 300 cycles per second can be tested in this equipment, with amplitudes of vibration up to 0.5-inch on the free end. Parts subjected to high operating temperatures, such as gas turbine buckets, can be fatigue tested at temperatures at which they operate, with the aid of an electrically heated furnace accessory. Since the specimens are vibrated under conditions which simulate actual dynamic loading conditions, and since the specimen is vibrated at its own resonant frequency, destructive test durations are usually short. Original use of the equipment was for testing jet engine turbine buckets at their resonant frequencies and 1500 F. Manufacturer: General Electric Co., Apparatus Dept., Schenectady, N. Y.



Hydraulic Fitting Standards for Industrial Equipment

By F. W. Robinson
Chief Engineer
V. L. Graf Company
New Baltimore, Mich.

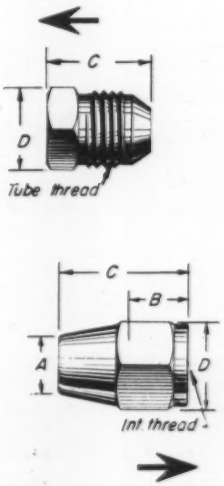
TO SIMPLIFY the procurement and replacement of fittings for hydraulic and other fluid conveying systems, the Joint Industry Conference on Hydraulic Standards for Industrial Equipment has recently completed its tube fitting Standard. This is to become a part of the JIC "Hydraulic Standards for Industrial Equipment" which was published in the December, 1948 issue of MACHINE DESIGN and these additional data are being presented in the hope that their availability will materially assist in promoting more uniform practices and improved service in the use of pressure-line fittings.

The standard series of fitting types and sizes in general conforms closely with the Army-Navy Aeronautical Standard. All design details are identical with the exception of the threads. Thread pitch and size conform to the AN Standard but the fit for AN fittings is specified as Class 3 while that for industrial or commercial use is Class 2.

Materials ordinarily employed for the fittings are brass, aluminum and steel. Brass and aluminum (17ST) are only employed on low or medium-pressure systems. Open-hearth or electric-furnace steels are used for the higher pressure systems, bar-stock or forged X1315, X1335 or X2330 steel being generally used. Forged fittings are heat treated or normalized to 90,000 to 110,000 psi tensile strength. Also, all steel fittings are cadmium plated with a thickness not under 0.0002 to 0.0003-inch to withstand a 100-hour salt-spray corrosion test.

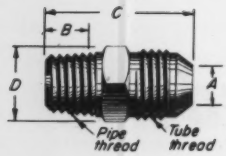
Performance in general must conform to AN Specification F366 regarding minimum requirements as noted in section H4.1.6 of the JIC Standard. As pointed out in the standard, where alignment is of paramount importance, pipe thread fittings are not used, the regular seal nose fitting with an O-ring under the face of the hex is preferred and now is gaining wide acceptance. The union type double-nose fitting has a hex size and facing specifically designed to permit this service.

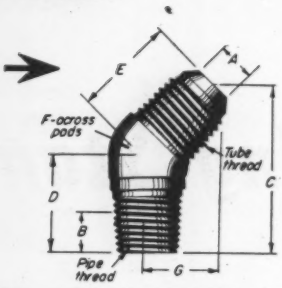
Tube OD	Thread Size	C	D
1/8	5/16-24	41/64	5/16
3/16	3/8-24	43/64	5/8
1/4	7/16-20	47/64	11/16
5/16	1/2-20	49/64	3/4
3/8	9/16-18	13/16	13/16
1/2	3/4-16	15/16	1
5/8	7/8-14	1 5/64	1 1/8
3/4	1 1/16-12	1 3/16	1 3/8
7/8	1 3/16-12	1 13/64	1 1/2
1	1 5/16-12	1 11/32	1 5/8
1 1/8	1 1/2-12	1 11/32	1 3/4
1 1/4	1 5/8-12	1 25/64	1 7/8
1 1/2	1 7/8-12	1 31/64	2 1/8
2	2 1/2-12	1 47/64	2 3/4



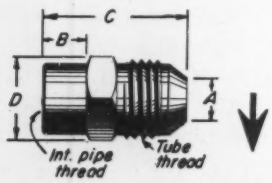
Tube OD	Thread Size	A	B	C	D
1/8	5/16-24	1/8	9/32	9/16	7/16
3/16	3/8-24	1/8	5/16	11/16	1/2
1/4	7/16-20	1/4	3/8	13/16	9/16
5/16	1/2-20	5/16	3/8	7/8	5/8
3/8	9/16-18	3/8	29/64	15/16	3/4
1/2	3/4-16	1/2	7/16	1 5/32	13/16
5/8	7/8-14	5/8	33/64	1 1/4	1 1/16
3/4	1 1/16-12	3/4	19/32	1 5/8	1 5/16
7/8	1 3/16-12	7/8	19/32	1 3/4	1 1/2
1	1 5/16-12	1	5/8	1 13/16	1 1/2
1 1/8	1 1/2-12	1 1/8	5/8	1 31/32	1 3/4
1 1/4	1 5/8-12	1 1/4	5/8	1 15/16	1 7/8
1 1/2	1 7/8-12	1 1/2	43/64	2 1/16	2 1/8
2	2 1/2-12	2	7/8	2 5/16	3

ENGINEERING DATA SHEET



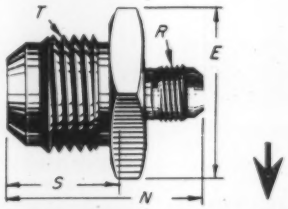


Tube OD	Thread Size	Pipe Thd.	A	B	C	D
1/8	5/16-24	1/8	1/16	9/32	1 1/64	7/16
3/16	3/8-24	1/8	1/8	9/32	1 3/64	7/16
1/4	7/16-20	1/8	11/64	9/32	1 7/64	7/16
5/16	1/2-20	1/8	15/64	9/32	1 9/64	1/2
5/16	1/2-20	1/4	15/64	13/32	1 3/8	9/16
3/8	9/16-18	1/4	19/64	13/32	1 3/8	9/16
1/2	3/4-16	3/8	25/64	13/32	1 1/2	3/4
1/2	3/4-16	1/4	25/64	13/32	1 1/2	3/4
5/8	7/8-14	1/2	31/64	17/32	1 53/64	7/8
5/8	7/8-14	3/8	31/64	13/32	1 41/64	7/8
3/4	1 1/16-12	3/4	39/64	17/32	1 61/64	1 1/8
3/4	1 1/16-12	1/2	39/64	17/32	1 61/64	1 1/8
7/8	1 3/16-12	3/4	23/32	17/32	1 61/64	1 3/8
1	1 5/16-12	1	27/32	21/32	2 7/32	1 3/8
1	1 5/16-12	3/4	27/32	17/32	2 9/16	2 1/8
1 1/8	1 1/2-12	1	15/16	21/32	2 9/32	1 5/8
1 1/4	1 5/8-12	1 1/4	1 5/64	11/16	2 23/64	1 11/16
1 1/4	1 5/8-12	1	1 5/64	21/32	2 31/64	1 11/16
1 1/2	1 7/8-12	1 1/2	1 5/16	11/16	2 9/16	2 1/8
2	2 1/2-12	2	1 25/32	3/4	3 7/64	2 5/8



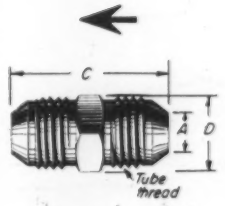
Tube OD	Thread Size	Pipe Thd.	A	B	C	D
1/8	5/16-24	1/8	1/16	9/32	1 5/32	9/16
3/16	3/8-24	1/8	1/8	9/32	1 5/16	9/16
1/4	7/16-20	1/8	11/64	9/32	1 1/4	9/16
5/16	1/2-20	1/8	15/64	9/32	1 1/4	9/16
5/16	1/2-20	1/4	15/64	13/32	1 7/16	3/4
3/8	9/16-18	1/4	19/64	13/32	1 7/16	3/4
1/2	3/4-16	3/8	25/64	13/32	1 9/16	7/8
1/2	3/4-16	1/4	25/64	13/32	1 9/16	3/4
5/8	7/8-14	1/2	31/64	17/32	1 15/16	1 1/8
5/8	7/8-14	3/8	31/64	13/32	1 11/16	7/8
3/4	1 1/16-12	3/4	39/64	17/32	2 1/16	1 3/8
3/4	1 1/16-12	1/2	39/64	17/32	2 1/16	1 1/8
7/8	1 3/16-12	3/4	23/32	17/32	2 1/16	1 3/8
1	1 5/16-12	1	27/32	21/32	2 5/16	1 5/8
1	1 5/16-12	3/4	27/32	17/32	2 1/8	1 1/2
1 1/8	1 1/2-12	1	15/16	21/32	2 5/16	1 5/8
1 1/4	1 5/8-12	1 1/4	1 5/64	11/16	2 7/16	2
1 1/4	1 5/8-12	1	1 5/64	21/32	2 5/8	1 11/16
1 1/2	1 7/8-12	1 1/2	1 5/16	11/16	2 29/32	2 1/2
2	2 1/2-12	2	1 25/32	3/4	3 1/32	3

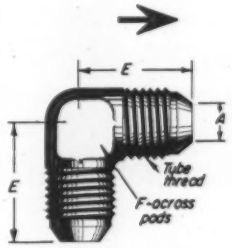
Tube OD	Thread Size	Pipe Thd.	A	B	D	E	F
1/8	5/16-24	1/8	1/16	9/32	1/2	41/64	7/16
3/16	3/8-24	1/8	1/8	9/32	1/2	41/64	7/16
1/4	7/16-20	1/8	11/64	9/32	5/8	45/64	7/16
5/16	1/2-20	1/8	15/64	9/32	5/8	3/4	1/2
3/8	9/16-18	1/4	19/64	13/32	27/32	13/16	9/16
1/2	3/4-16	3/8	25/64	13/32	15/16	31/32	3/4
5/8	7/8-14	1/2	31/64	17/32	1 5/32	1 5/32	7/8
3/4	1 1/16-12	3/4	39/64	17/32	1 5/16	1 17/64	1 1/16
7/8	1 3/16-12	3/4	23/32	17/32	1 1/4	1 21/64	1 5/16
1	1 5/16-12	1	27/32	21/32	1 15/32	1 29/64	1 5/16
1 1/8	1 1/2-12	1	15/16	21/32	1 15/32	1 37/64	1 5/16
1 1/4	1 5/8-12	1 1/4	1 5/64	11/16	1 21/32	1 27/64	1 5/8
1 1/2	1 7/8-12	1 1/2	1 5/16	11/16	2	1 49/64	1 7/8
2	2 1/2-12	2	1 25/32	3/4	2 5/32	2 13/64	2 5/16

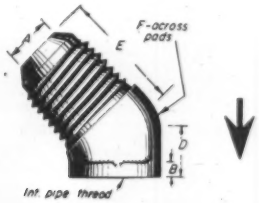


Tube OD	Thread T	Tube OD	Thread R	E	N	S
3/16	3/8-24	1/8	5/16-24	.625	1 11/64	5/8
1/4	7/16-20	1/8	5/16-24	.688	1 1/4	11/16
1/4	7/16-20	3/16	3/8-24	.688	1 9/32	37/64
5/16	1/2-20	1/4	7/16-20	.750	1 23/64	39/64
3/8	9/16-18	1/8	5/16-24	.813	1 19/64	5/8
3/8	9/16-18	3/16	3/8-24	.813	1 21/64	5/8
3/8	9/16-18	1/4	7/16-20	.813	1 13/32	5/8
3/8	9/16-18	5/16	1/2-20	.813	1 13/32	5/8
1/2	3/4-16	1/8	5/16-24	1.000	1 27/64	21/32
1/2	3/4-16	3/16	3/8-24	1.000	1 29/64	23/32
1/2	3/4-16	1/4	7/16-20	1.000	1 17/32	23/32
1/2	3/4-16	5/16	1/2-20	1.000	1 17/32	23/32
1/2	3/4-16	3/8	9/16-16	1.000	1 17/32	23/32
5/8	7/8-14	1/4	7/16-20	1.125	1 21/32	51/64
5/8	7/8-14	3/8	9/16-18	1.125	1 21/32	51/64
5/8	7/8-14	1/2	3/4-16	1.125	1 3/4	51/64
3/4	1 1/16-12	1/4	7/16-20	1.375	1 51/64	57/64
3/4	1 1/16-12	5/16	1/2-20	1.375	1 51/64	57/64
3/4	1 1/16-12	3/8	9/16-18	1.375	1 51/64	57/64
3/4	1 1/16-12	1/2	3/4-16	1.375	1 57/64	57/64
3/4	1 1/16-12	5/8	7/8-14	1.375	2	57/64
7/8	1 3/16-12	1/2	3/4-16	1.500	1 7/8	57/64
7/8	1 3/16-12	5/8	7/8-14	1.500	2	57/64
7/8	1 3/16-12	3/4	1 1/16-12	1.500	2 5/64	57/64
1	1 5/16-12	1/4	7/16-20	1.625	1 27/32	57/64
1	1 5/16-12	5/8	7/8-14	1.625	2 5/64	57/64
1	1 5/16-12	3/4	1 1/16-12	1.625	2 5/32	57/64
1 1/8	1 1/2-12	3/4	1 1/16-12	1.750	2 13/64	57/64
1 1/8	1 1/2-12	7/8	1 3/16-12	1.750	2 1/4	57/64
1 1/8	1 1/2-12	1	1 5/16-12	1.750	2 1/4	57/64
1 1/4	1 5/8-12	1/4	7/16-20	1.875	1 57/64	55/64
1 1/4	1 5/8-12	3/4	1 1/16-12	1.875	2 1/4	55/64
1 1/4	1 5/8-12	1	1 5/16-12	1.875	2 1/4	55/64
1 1/2	1 7/8-12	1	1 5/16-12	2.125	2 33/64	29/32
1 1/2	1 7/8-12	1 1/4	1 5/8-12	2.125	2 13/32	29/32

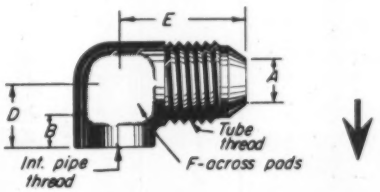
Tube OD	Thread Size	A	C	D
⅛	5/16-24	1/16	17/32	9/16
3/16	3/8-24	⅛	17/32	5/8
¼	7/16-20	11/64	1¼	11/16
5/16	½-20	15/64	1¼	¾
⅜	9/16-18	19/64	1⅜	13/16
½	¾-16	25/64	1 9/16	1
⅝	7/8-14	31/64	1 53/64	1⅛
¾	1 1/16-12	39/64	2 7/64	1⅜
⅞	1 3/16-12	23/32	2 7/64	1⅜
1	1 5/16-12	27/32	2 5/16	1⅝
1⅛	1½-12	15/16	2¼	1⅝
1¼	1⅝-12	1 5/64	2 9/32	1 7/8
1½	1 7/8-12	1 5/16	2 17/32	2⅛
2	2½-12	1 31/32	3 1/16	2¾





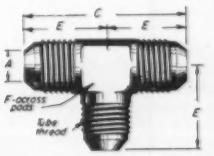


Tube OD	Thread Size	Pipe Thd.	A	B	D	E	F
¼	7/16-20	⅛	11/64	9/32	9/16	¾	½
⅜	9/16-18	¼	19/64	13/32	23/32	⅞	¾
½	¾-16	⅜	25/64	13/32	¾	1	⅞
⅝	⅞-14	½	31/64	17/32	1	1 1/16	1 1/16
⅞	1 3/16-12	¾	23/32	17/32	1¼	1 21/64	1 5/16
1⅛	1½-12	1	15/16	21/32	1⅜	1⅝	1⅝

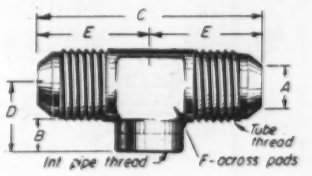


Tube OD	Thread Size	Pipe Thd.	A	B	D	E	F
⅛	5/16-24	⅛	1/16	9/32	9/16	⅞	½
3/16	3/8-24	⅛	⅛	9/32	9/16	57/64	½
¼	7/16-20	⅛	11/64	9/32	9/16	61/64	½
5/16	½-20	⅛	15/64	9/32	9/16	59/64	½
5/16	½-20	¼	15/64	13/32	23/32	1 13/32	¾
⅜	9/16-18	¼	19/64	13/32	23/32	1 9/64	¾
½	¾-16	⅜	25/64	13/32	¾	1 5/16	⅞
½	¾-16	¼	25/64	13/32	23/32	1 7/32	¾
⅝	⅞-14	½	31/64	17/32	1	1 17/32	1
⅝	⅞-14	⅜	31/64	13/32	¾	1 37/64	1
¾	1 1/16-12	¾	39/64	17/32	1⅛	1⅞	1⅜
¾	1 1/16-12	½	39/64	17/32	1	1⅝	1 1/16
⅞	1 3/16-12	¾	23/32	17/32	1⅛	1 15/16	1⅜
1	1 5/16-12	1	27/32	21/32	1¼	2 5/64	1⅝
1	1 5/16-12	¾	27/32	17/32	1⅛	1 25/32	1 5/16
1⅛	1½-12	1	15/16	21/32	1¼	2 1/16	1⅝
1¼	1⅝-12	1¼	1 5/64	11/16	1¾	2¼	1⅞
1¼	1⅝-12	1	1 5/64	21/32	1¼	2	1⅝
1½	1⅞-12	1½	1 5/16	11/16	2 5/16	2¾	2¼
2	2½-12	2	1 31/32	¾	2⅝	3⅛	3

Tube OD	Thread Size	A	E	F
⅛	5/16-24	1/16	49/64	⅜
3/16	3/8-24	⅛	51/64	⅜
¼	7/16-20	11/64	55/64	7/16
5/16	½-20	15/64	59/64	½
⅜	9/16-18	19/64	1 1/32	9/16
½	¾-16	25/64	1 7/32	¾
⅝	⅞-14	31/64	1 27/64	⅞
¾	1 1/16-12	39/64	1 31/32	1 1/16
⅞	1 3/16-12	23/32	1 13/16	1 3/16
1	1 5/16-12	27/32	1 25/32	1 5/16
1⅛	1½-12	15/16	1 15/16	1 5/16
1¼	1⅝-12	1 5/64	2 1/32	1⅝
1½	1 7/8-12	1 5/16	2½	1⅞
2	2½-12	1 31/32	3 1/16	3



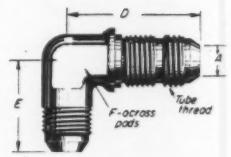
Tube OD	Thread Size	A	C	E	F
⅛	5/16-24	1/16	1½	¾	⅜
3/16	3/8-24	⅛	1⅝	13/16	⅜
¼	7/16-24	11/64	1¾	⅞	7/16
5/16	½-20	15/64	1⅞	15/16	½
⅜	9/16-18	19/64	2⅛	1 1/16	9/16
½	¾-16	25/64	2½	1¼	¾
⅝	⅞-14	31/64	2⅞	1 7/16	⅞
¾	1 1/16-12	39/64	3 5/16	1 21/32	1 1/16
⅞	1 3/16-12	23/32	3½	1¾	1 3/16
1	1 5/16-12	27/32	3 5/8	1 13/16	1 5/16
1⅛	1½-12	15/16	3 15/16	1 31/32	1 5/16
1¼	1⅝-12	1 5/64	4⅛	2 1/16	1⅝
1½	1 7/8-12	1 5/16	4⅝	2 5/16	1⅞
2	2½-12	1 31/32	6⅛	3 1/16	2 9/16



Tube OD	Thread Size	Pipe Thd.	A	B	C	D	E	F
⅛	5/16-24	⅛	1/16	9/32	1¾	9/16	⅞	½
3/16	3/8-24	⅛	⅛	9/32	1 25/32	9/16	57/64	½
¼	7/16-20	⅛	11/64	9/32	1 15/16	9/16	31/32	½
5/16	½-20	⅛	15/64	9/32	1 15/16	9/16	31/32	½
⅜	9/16-18	¼	19/64	13/32	2 9/32	¾	1 9/64	¾
½	¾-16	⅜	25/64	13/32	2⅜	¾	1 5/16	⅞
⅝	⅞-14	½	31/64	17/32	3 1/16	1	1 17/32	1 1/16
¾	1 1/16-12	¾	39/64	17/32	3 5/16	1⅛	1 13/16	1 5/16
⅞	1 3/16-12	¾	23/32	17/32	3¾	1⅛	1⅞	1 5/16
1	1 5/16-12	1	27/32	21/32	4 5/32	1¾	2 5/64	1⅝
1⅛	1½-12	1	15/16	21/32	4⅞	1¾	2⅜	1⅝
1¼	1⅝-12	1¼	1 5/64	11/16	4¾	1¾	2⅜	1⅞
1½	1⅞-12	1½	1 5/16	11/16	5⅜	2 5/16	2 13/16	2 5/16
2	2½-12	2	1 31/32	¾	6⅛	2⅝	3 1/32	2 5/16

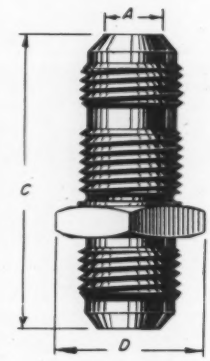
ENGINEERING DATA SHEET

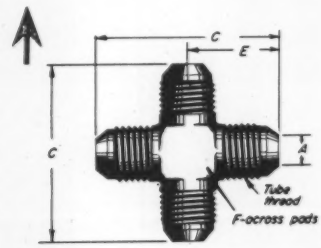
Tube OD	Thread Size	A	D	E	F
1/8	5/16-24	1/16	1 13/32	53/64	5/16
3/16	3/8-24	1/8	1 7/16	57/64	3/8
1/4	7/16-20	11/64	1 37/64	61/64	7/16
5/16	1/2-20	15/64	1 39/64	1 1/64	1/2
3/8	9/16-18	19/64	1 51/64	1 5/64	9/16
1/2	3/4-16	25/64	2 3/32	1 11/32	3/4
5/8	7/8-14	31/64	2 3/8	1 35/64	7/8
3/4	1 1/16-12	39/64	2 21/32	1 49/64	1 1/16
7/8	1 3/16-12	23/32	2 25/32	1 39/32	1 5/16
1	1 5/16-12	27/32	2 25/32	1 59/64	1 5/16
1 1/8	1 1/2-12	15/16	3 3/32	2 1/4	1 5/8
1 1/4	1 5/8-12	1 5/64	3 7/64	2 5/32	1 5/8
1 1/2	1 7/8-12	1 5/16	3 13/32	2 21/64	1 7/8
2	2 1/2-12	1 25/32	4 3/32	2 7/8	2 9/16

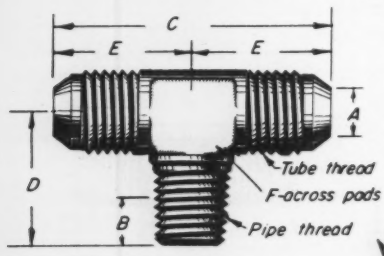


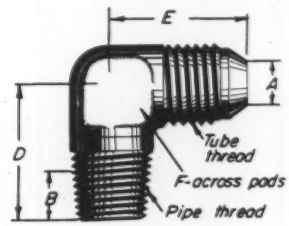
Tube OD	Thread Size	A	C	E	F
1/8	5/16-24	1/16	1 1/2	3/4	3/
3/16	3/8-24	1/8	1 5/8	13/16	3/
1/4	7/16-20	11/64	1 3/4	7/8	7/
5/16	1/2-20	15/64	1 7/8	15/16	1/
3/8	9/16-18	19/64	2 1/8	1 1/16	9/
1/2	3/4-16	25/64	2 1/2	1 1/4	3/
5/8	7/8-14	31/64	2 7/8	1 7/16	7/
3/4	1 1/16-12	39/64	3 5/16	1 31/32	1 1/
7/8	1 3/16-12	23/32	3 11/16	1 27/32	1 5/
1	1 5/16-12	27/32	3 5/8	1 13/16	1 5/
1 1/8	1 1/2-12	15/16	3 15/16	1 31/32	1 5/
1 1/4	1 5/8-12	1 5/64	4 1/8	2 1/16	1 5/
1 1/2	1 7/8-12	1 5/16	4 5/8	2 5/16	1 7/
2	2 1/2-12	1 25/32	6 1/8	3 1/16	2 9/

Tube OD	Thread Size	A	C	D
1/8	5/16-24	1/16	1 53/64	9/16
3/16	3/8-24	1/8	1 55/64	5/8
1/4	7/16-20	11/64	2 3/64	11/16
5/16	1/2-20	15/64	2 3/64	3/4
3/8	9/16-18	19/64	2 7/32	13/16
1/2	3/4-16	25/64	2 29/64	1
5/8	7/8-14	31/64	2 33/32	1 1/8
3/4	1 1/16-12	39/64	3 1/32	1 3/8
7/8	1 3/16-12	23/32	3 1/32	1 1/2
1	1 5/16-12	27/32	3 5/64	1 5/8
1 1/8	1 1/2-12	15/16	3 5/64	1 3/4
1 1/4	1 5/8-12	1 5/64	3 5/32	1 7/8
1 1/2	1 7/8-12	1 5/16	3 5/16	2 1/8
2	2 1/2-12	1 25/32	3 53/64	2 3/4





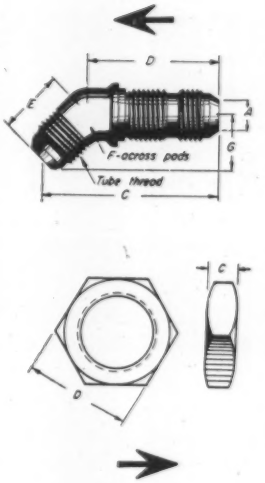




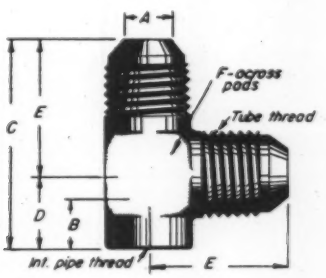
Tube OD	Thd. Size	Pipe Thd.	A	B	C	C_1	D	E	F
1/8	5/16-24	1/8	1/16	9/32	1 1/2	1 7/16	11/16	3/4	3/8
3/16	3/8-24	1/8	1/8	9/32	1 5/8	1 1/2	11/16	13/16	3/8
1/4	7/16-20	1/8	11/64	9/32	1 3/4	1 5/8	3/4	7/8	7/16
5/16	1/2-20	1/8	15/64	9/32	1 7/8	1 11/16	3/4	15/16	1/2
3/8	9/16-18	1/4	19/64	13/32	2 1/8	2 1/8	1 1/16	1 1/16	9/16
1/2	3/4-16	3/8	25/64	13/32	2 1/2	2 7/16	1 3/16	1 1/4	3/4
5/8	7/8-14	1/2	31/64	17/32	2 7/8	2 7/8	1 7/16	1 7/16	7/8
3/4	1 1/16-12	3/4	39/64	17/32	3 5/16	3 7/32	1 9/16	1 31/32	1 1/16
7/8	1 3/16-12	3/4	23/32	17/32	3 11/16	3 17/32	1 11/16	1 27/32	1 5/16
1	1 5/16-12	1	27/32	21/32	3 5/8	3 3/4	1 13/16	1 13/16	1 5/16
1 1/8	1 1/2-12	1	15/16	21/32	3 15/16	4	2 1/32	1 31/32	1 5/16
1 1/4	1 5/8-12	1 1/4	1 5/64	11/16	4 1/8	4 13/32	2 11/32	2 1/16	1 5/8
1 1/2	1 7/8-12	1 1/2	1 5/16	11/16	4 5/8	5 1/16	2 3/4	2 5/16	1 7/8
2	2 1/2-12	2	1 25/32	3/4	6 1/8	6 1/16	3	3 1/16	2 3/16

Tube OD	Thread Size	Pipe Thd.	A	B	D	E	F
1/8	5/16-24	1/8	1/16	9/32	11/16	47/64	3/8
3/16	3/8-24	1/8	1/8	9/32	11/16	51/64	3/8
1/4	7/16-20	1/8	11/64	9/32	3/4	55/64	7/16
5/16	1/2-20	1/8	15/64	9/32	3/4	59/64	1/2
5/16	1/2-20	1/4	15/64	13/32	1 1/16	1 1/32	9/16
3/8	9/16-18	1/4	19/64	13/32	1 1/16	1 1/32	9/16
1/2	3/4-16	3/8	25/64	11/32	1 3/16	1 7/32	3/4
1/2	3/4-16	1/4	25/64	13/32	1 3/16	1 7/32	3/4
5/8	7/8-14	1/2	31/64	17/32	1 7/16	1 27/64	7/8
5/8	7/8-14	3/8	31/64	11/32	1 7/32	1 27/64	7/8
3/4	1 1/16-12	3/4	39/64	17/32	1 19/32	1 31/32	1 1/16
3/4	1 1/16-12	1/2	39/64	17/32	1 9/16	1 5/8	1 1/16
7/8	1 3/16-12	3/4	23/32	17/32	1 11/16	1 3/4	1 1/16
1	1 5/16-12	1	27/32	21/32	1 13/16	1 25/32	1 5/16
1	1 5/16-12	3/4	27/32	17/32	1 11/16	1 25/32	1 5/16
1 1/8	1 1/2-12	1	15/16	21/32	2 1/16	2	1 5/8
1 1/4	1 5/8-12	1 1/4	1 5/64	11/16	2 11/32	2 1/32	1 5/8
1 1/4	1 5/8-12	1	1 5/64	21/32	2 11/32	2	1 5/8
1 1/2	1 7/8-12	1 1/2	1 5/16	11/16	2 1/2	2 1/2	1 7/8
2	2 1/2-12	2	1 25/32	3/4	3	3 1/16	3

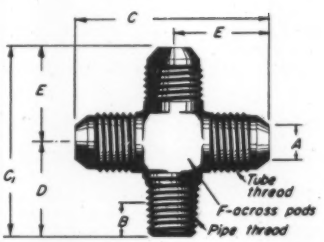
Tube OD	Thread Size	A	D	E	F
1/8	5/16-24	1/16	1 3/8	41/64	5/16
3/16	3/8-24	1/8	1 3/8	41/64	3/8
1/4	7/16-20	11/64	1 17/32	45/64	7/16
5/16	1/2-20	13/64	1 17/32	3/4	1/2
3/8	9/16-18	19/64	1 43/64	13/16	9/16
1/2	3/4-16	25/64	1 13/16	31/32	3/4
5/8	7/8-14	31/64	2 11/64	1 5/32	7/8
3/4	1 1/16-12	39/64	2 7/16	1 17/64	1 1/16
7/8	1 3/16-12	23/32	2 9/16	1 7/16	1 3/16
1	1 5/16-12	27/32	2 9/16	1 39/64	1 5/16
1 1/8	1 1/2-12	15/16	2 31/32	1 5/16	1 5/8
1 1/4	1 5/8-12	1 5/64	2 31/32	1 37/64	1 5/8
1 1/2	1 7/8-12	1 5/16	2 43/64	1 49/64	1 7/8
2	2 1/2-12	1 35/32	2 29/32	2 13/64	2 9/16

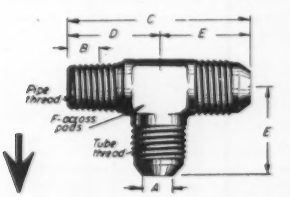


Tube OD	Thread Size	C	D
1/8	5/16-24	7/32	9/16
3/16	3/8-24	7/32	5/8
1/4	7/16-20	1/4	11/16
5/16	1/2-20	1/4	3/4
3/8	9/16-18	17/64	13/16
1/2	3/4-16	5/16	1
5/8	7/8-14	23/64	1 1/8
3/4	1 1/16-12	13/32	1 3/8
7/8	1 3/16-12	13/32	1 1/2
1	1 5/16-12	13/32	1 5/8
1 1/8	1 1/2-12	13/32	1 3/4
1 1/4	1 5/8-12	13/32	1 15/16
1 1/2	1 7/8-12	13/32	2 5/16
2	2 1/2-12	13/32	2 13/16



Tube OD	Thread Size	Pipe Thd.	A	B	C	D	E	F
1/8	5/16-24	1/8	1/16	9/32	1 7/16	9/16	7/8	1/2
3/16	3/8-24	1/8	1/8	9/32	1 39/64	9/16	57/64	1/2
1/4	7/16-20	1/8	11/64	9/32	1 17/32	9/16	31/32	1/2
5/16	1/2-20	1/8	15/64	9/32	2	15/16	1 1/16	9/16
3/8	9/16-18	1/4	19/64	13/32	1 55/64	23/32	1 9/64	3/4
1/2	3/4-16	3/8	25/64	13/32	2 1/16	3/4	1 5/16	7/8
5/8	7/8-14	1/2	31/64	17/32	2 17/32	1	1 17/32	1 1/16
3/4	1 1/16-12	3/4	39/64	17/32	3	1 3/16	1 13/16	1 5/16
7/8	1 3/16-12	3/4	23/32	17/32	3 1/16	1 3/16	1 7/8	1 5/16
1	1 5/16-12	1	27/32	21/32	3 31/64	1 1/4	2 5/64	1 5/8
1 1/8	1 1/2-12	1	15/16	21/32	3 33/64	1 1/4	2 7/64	1 5/8
1 1/4	1 5/8-12	1 1/4	1 5/64	11/16	4 1/8	1 3/4	2 3/8	1 7/8
1 1/2	1 7/8-12	1 1/2	1 5/16	11/16	4 33/64	2 5/16	2 13/16	2 5/16
2	2 1/2-12	2	1 35/64	3/4	5 11/16	2 5/8	3 1/16	2 5/16





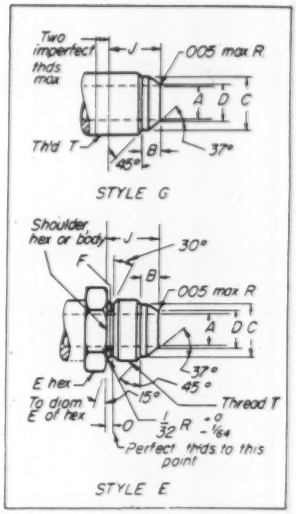
Tube OD	Thread Size	Pipe Thd.	A	B	C	D	E	F
1/8	5/16-24	1/8	1/16	9/32	1 1/2	23/32	3/4	3/8
3/16	3/8-24	1/8	1/8	9/32	1 5/8	23/32	13/16	3/8
1/4	7/16-20	1/8	11/64	9/32	1 3/4	23/32	7/8	7/16
5/16	1/2-20	1/8	15/64	9/32	1 7/8	23/32	15/16	1/2
3/8	9/16-18	1/4	19/64	13/32	2 1/8	1 3/32	1 1/16	9/16
1/2	3/4-16	3/8	25/64	13/32	2 1/2	1 7/32	1 1/4	3/4
5/8	7/8-14	1/2	31/64	17/32	2 7/8	1 15/32	1 7/16	7/8
3/4	1 1/16-12	3/4	33/64	17/32	3 5/16	1 19/32	1 31/32	1 1/16
7/8	1 3/16-12	3/4	23/32	17/32	3 1/2	1 11/16	1 3/4	1 3/16
1	1 5/16-12	1	17/32	21/32	3 5/8	1 31/32	1 13/16	1 5/16
1 1/8	1 1/2-12	1	15/16	21/32	3 15/16	1 31/32	1 31/32	1 5/16
1 1/4	1 5/8-12	1 1/4	1 5/64	11/16	4 3/8	2 3/8	2 1/16	1 5/8
1 1/2	1 7/8-12	1 1/2	1 5/16	11/16	4 5/8	2 3/8	2 1/16	1 7/8
2	2 1/2-12	2	1 35/64	3/4	6 1/8	3	3 1/16	2 1/16

Tube OD	Thread Size	Pipe Thd.	A	B	C	D	E	F
1/8	5/16-24	1/8	1/16	9/32	1 15/32	23/32	3/4	3/8
3/16	3/8-24	1/8	1/8	9/32	1 17/32	23/32	13/16	3/8
1/4	7/16-20	1/8	11/64	9/32	1 21/32	23/32	7/8	7/16
5/16	1/2-20	1/8	15/64	9/32	1 23/32	23/32	15/16	1/2
3/8	9/16-18	1/4	19/64	13/32	2 5/32	1 13/32	1 1/16	9/16
1/2	3/4-16	3/8	25/64	13/32	2 15/32	1 17/32	1 1/4	3/4
5/8	7/8-14	1/2	31/64	17/32	2 29/32	1 15/32	1 7/16	7/8
3/4	1 1/16-12	3/4	39/64	17/32	3 1/4	1 19/32	1 31/32	1 1/16
7/8	1 3/16-12	3/4	23/32	17/32	3 7/16	1 11/16	1 3/4	1 3/16
1	1 5/16-12	1	27/32	21/32	3 35/32	1 31/32	1 13/16	1 5/16
1 1/8	1 1/2-12	1	15/16	21/32	3 15/16	1 31/32	1 31/32	1 5/16
1 1/4	1 5/8-12	1 1/4	1 5/64	11/16	4 7/16	2 3/8	2 1/16	1 5/8
1 1/2	1 7/8-12	1 1/2	1 5/16	11/16	4 13/16	2 3/8	2 1/16	1 7/8
2	2 1/2-12	2	1 35/64	3/4	6 1/16	3	3 1/16	2 1/16

ENGINEERING DATA SHEET

Standard Seal Nose Dimensions

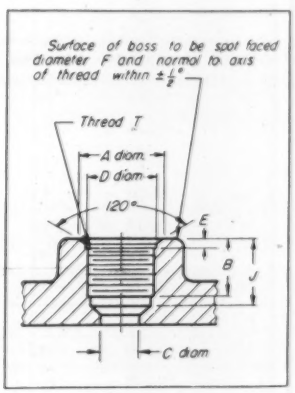
Tubing OD	Thread T	A ±.003 Diam	B +.015 −.000	C ±.003 Diam	D ±.003 Diam	E	F +.002 −.003	J ±.015	O +.015 −.000	M Min
1/8	5/16-24 NF-3	.062	.177	.251	.083	.563 +.003 −.006	.250	.448	.063	.005
3/16	3/8-24 NF-3	.125	.177	.313	.146	.625 +.003 −.006	.313	.479	.063	.005
1/4	7/16-20 NF-3	.172	.193	.365	.193	.688 +.003 −.006	.364	.550	.075	.005
5/16	1/2-20 NF-3	.234	.193	.427	.255	.750 +.003 −.006	.427	.550	.075	.005
3/8	9/16-18 NF-3	.297	.198	.482	.318	.813 +.003 −.006	.482	.556	.083	.005
1/2	3/4-16 NF-3	.391	.253	.661	.426	1.000 +.003 −.006	.660	.657	.094	.012
5/8	7/8-14 NF-3	.484	.266	.774	.539	1.125 +.003 −.006	.773	.758	.107	.022
3/4	1 1/16-12 N-3	.609	.315	.945	.664	1.375 +.003 −.006	.945	.864	.125	.022
1	1 5/16-12 N-3	.844	.315	1.195	.913	1.625 +.008 −.016	1.195	.911	.125	.029
1 1/4	1 5/8-12 N-3	1.078	.367	1.507	1.147	1.875 +.009 −.016	1.507	.958	.125	.029
1 1/2	1 7/8-12 N-3	1.312	.378	1.757	1.381	2.125 +.010 −.020	1.756	1.083	.125	.029
1 3/4	2 1/4-12 N-3	1.547	.451	2.132	1.646	2.500 +.013 −.020	2.131	1.208	.125	.044
2	2 1/2-12 N-3	1.781	.461	2.382	1.880	2.750 +.014 −.020	2.381	1.333	.125	.044



1. Diameters *D*, *C*, *F*, and *T* (pitch diameter) shall be concentric with each other within 0.005-inch total indicator reading.
2. Sealing nose surface shall be free from burrs, longitudinal and spiral tool marks, and shall be smooth, except annular tool marks will be permissible up to 100 microinches rms, maximum. Remove all other burrs and sharp edges.
3. Dimensions in inches. Tolerances on angles ± ½-degree.
4. Style *E* end required only when fitting is used as gasket seat. When style *G* is specified, undercut *F* may be omitted, in which case perfect threads shall extend to length *J*.

Standard Gasket Seat Dimensions

Tubing OD	Thread T	A +.015 −.000	B Min	C Min	D +.005 −.000	E +.015 −.000	F Min	J Min
1/8	5/16-24 NF-3	.437	3/8	.081	.324	.063	21/32	1/2
3/16	3/8-24 NF-3	.502	13/32	.144	.386	.063	23/32	1/2
1/4	7/16-20 NF-3	.562	7/16	.206	.450	.075	51/64	19/32
5/16	1/2-20 NF-3	.625	7/16	.257	.513	.075	15/16	19/32
3/8	9/16-18 NF-3	.687	15/32	.319	.577	.083	15/16	19/32
1/2	3/4-16 NF-3	.875	9/16	.444	.767	.094	1 15/64	23/32
5/8	7/8-14 NF-3	1.000	5/8	.555	.893	.107	1 19/64	25/32
3/4	1 1/16-12 N-3	1.237	11/16	.680	1.083	.125	1 31/32	29/32
1	1 5/16-12 N-3	1.487	11/16	.930	1.333	.125	1 61/64	15/16
1 1/4	1 5/8-12 N-3	1.800	11/16	1.180	1.646	.125	2 1/4	63/64
1 1/2	1 7/8-12 N-3	2.050	3/4	1.430	1.897	.125	2 17/32	1 1/8
1 3/4	2 1/4-12 N-3	2.425	13/16	1.680	2.272	.125	2 31/32	1 1/4
2	2 1/2-12 N-3	2.675	15/16	1.930	2.522	.125	3 1/4	1 3/8

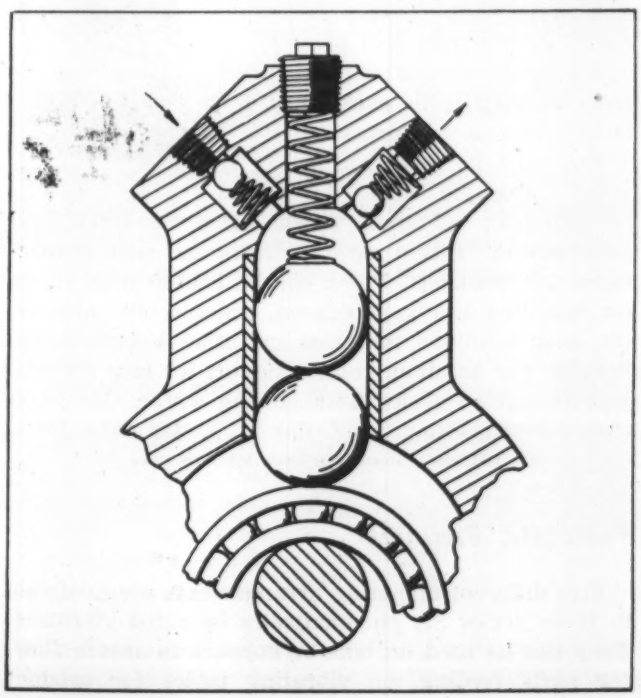


1. The countersink to *A* diameter and counterbore to *D* diameter shall be a smooth machine finish. Remove all burrs and sharp edges.
2. Dimensions in inches. Tolerances on angles ± ½ degree.
3. When dia. *C* equals tap drill dia., the height of the boss may equal *J*.
4. Diameters *A*, *D* and *T* (pitch diameter) shall be concentric within 0.005-inch total indicator reading.

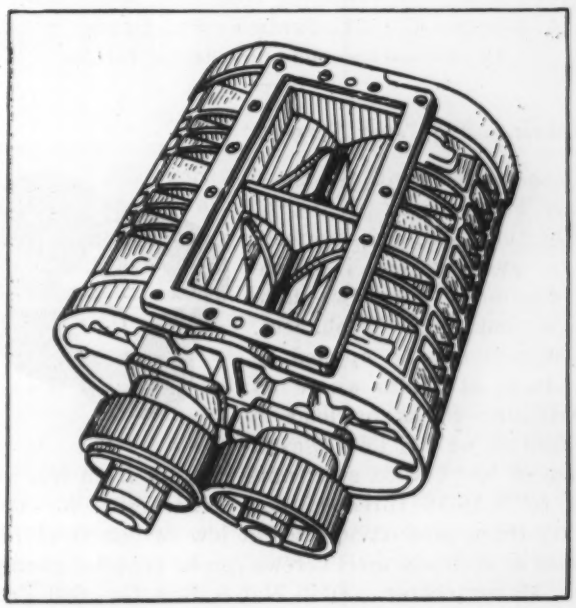
Noteworthy Patents

COMPACT REDUCTION DRIVE is obtained with a novel motor or generator unit which incorporates planetary reduction gearing within the rotor core. Reducing the space required and eliminating misalignment between gearing and power unit, the geared motor or generator units described in patent 2,450,290 have been assigned to the General Electric Co. by Hugh S. Maxwell. When used in motor applications, the inner bore of the rotor core is enlarged to accommodate a gear train consisting of stationary sun gears, planetary tracking and drive gears on a common shaft, and output shaft gears. The entire gear assembly is surrounded by an oil and grease tight enclosure to prevent lubricant leakage between the rotor laminations.

A BALL PISTON design for reciprocating type pumps eliminates the uneven distribution of friction between cylindrical pistons and cylinder walls. In conventional arrangements, variations in piston or cylinder diameter together with the angle at which the connecting rod applies force to the piston result in higher friction and consequently higher wear on certain sections of the cylinder bore. In the design covered in patent 2,463,486 granted to Clarence Johnson and assigned to the Bailey Meter Co., one or more precision-ground balls serve in the capacity of a piston element. Only line contact with the cylinder wall is made by the balls and, if resistance to sliding movement of the balls in the bore becomes greater at any one point, it merely causes the ball or balls to roll in the cylinder. No connecting rod is required for the ball piston, an eccentric, with return spring where necessary, being used to impart reciprocating motion to the balls. Excessive leakage from one side of the balls to the other is prevented successfully by the narrow line contact of the balls.



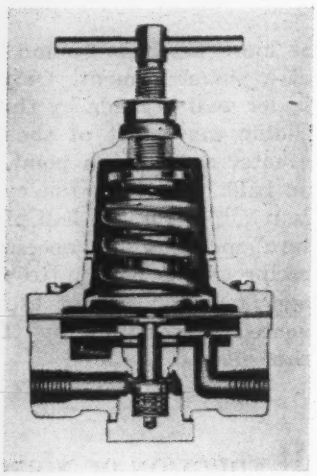
REDUCTION OF NOISE due to pulsations in Root type rotary blowers is accomplished by providing a gradually widening orifice to slowly pass air from the high pressure discharge side of the blower to the lower pressure areas between the rotor lobes. In the conventional rectangular blower outlet, air which has been compressed at the outlet is free to rush back into the space between the following lobes with considerable force, setting up pulsations and resulting in excessive noise. The triangular shaped outlets covered in patent 2,463,080 permit a uniform rate of pressure rise of the entrapped air between the lobes without pressure pulsations. Kurt A. Beier has assigned the patent to Schwitzer-Cummins Co.



new parts and materials

For additional information on these new developments see Page 153

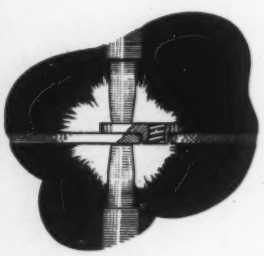
Pressure Regulator



Suitable for use on ¼ to 1-inch pipe lines carrying air or noncorrosive gases and such fluids as oil and cold water, adjustable type 2AX relieving pressure regulator provides positive protection against creep. It can be used at line pressures up to 400 psi and for working pressures up to 250 psi. Relief valve action is simple and positive permitting downward adjustment of pressure without bleeding the line. Baffle-plate-with-syphon-tube feature allows greater flow with less pressure drop than with conventional valves. Regulator is installed through straight pipe connections and can be disassembled if necessary without removing from line. Manufacturer: C. A. Norgren Co., 222 Santa Fe Dr., Denver 9, Colo.

For additional information circle MD 1 on Page 153

Welding Nuts and Screws



Easily attached to sheet steel surfaces by means of projection welding, Spotweld nuts and screws facilitate production of domestic, office and industrial appliances. Fasteners can be applied to products at points where no particular stress or load is placed on welded joint. Seven sizes of low carbon steel nuts ranging from No. 8-32 up to 5/16-18 threaded hole are carried in stock. Sixty-three production sizes of low carbon steel, high brass or stainless steel screws can be supplied promptly. Manufacturer: Ohio Nut & Bolt Co., 600 Front St., Berea, O.

For additional information circle MD 2 on Page 153

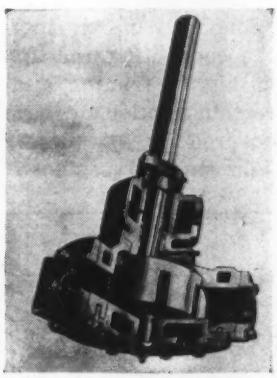
Alternators

Permitting top capacity of 300 kw at 1800 rpm, 60 cycles, new alternators are available at speeds of 720, 900, 1200 and 1800 rpm. All rotors are constructed with dampener windings to facilitate parallel operation. They are banded with steel wire to protect field windings from centrifugal force damage due to moderate over speed. Stator, made of 26 gauge coated dynamo steel with ⅜-inch ventilating air space for each 3 inches of lamination stack, is held in an all-welded steel frame. Mounting feet are widely spaced to facilitate generator line up for coupling or belt drive. Four lifting rings are provided for handling by hoist. Large junction cabinet is built on the outlet side providing room for making conduit attachment. Voltage regulator control panel is mounted on top of the cabinet to eliminate external switchboard and reduce installation cost.

Alternators are available with direct-connected exciter on the high-speed designs and top-mounted exciters on the lower speeds. Direct-mounted exciters are arranged so that the exciter armature may be removed without dismantling the alternator. Top-mounted exciters have an adjustable base so that V-belts may be kept at proper tension. Manufacturer: Kato Engineering Co., Mankato, Minn.

For additional information circle MD 3 on Page 153

Jacketed Pumps



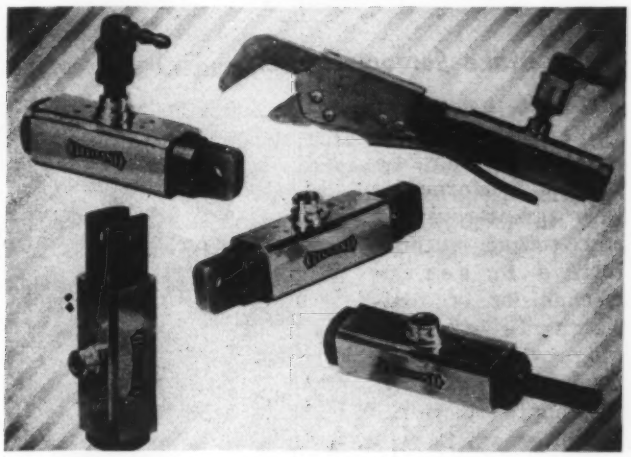
Having capacities of 90, 200, 300 and 400 gpm, jacketed pumps feature individual jackets for casing, head and rotor bearing sleeve. Jacket on rotor bearing sleeve makes possible heating of packing to retain its pliability and prevent liquid being handled from solidifying in packing box. Pumps incorporate Viking rotary "gear within gear" principle and are furnished in all iron, bronze-fitted or steel-fitted construction. Either right or left-hand port connections are available. Pump can be heated with steam for handling heavy petroleum, organic oils, greases, tar, soap solutions, molasses and other heavy viscous liquids. For handling volatile liquids for long periods, jackets can be cooled with cooling water. Manufacturer: Viking Pump Co., Cedar St., Cedar Falls, Iowa.

For additional information circle MD 4 on Page 153

Pneumatic Vibrators

Five different mounting arrangements are available in these series SA pneumatically operated vibrators. They can be used on bins or hoppers to assure flow, for parts feeding, on vibrating tables for product

packaging, on fatigue testing units and other applications where constant or intermittent vibration is required. Seven sizes are available with ⅜ to 1¼-inch pistons and speeds of 5100 to 1950 cycles per



minute. Chromed steel body is microfinished, and ground chrome-plated piston is heat treated. Manufacturer: Cleveland Vibrator Co., Clinton Ave., Cleveland 13, O.

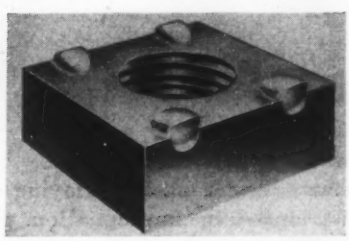
For additional information circle MD 5 on Page 153

Small Industrial Wheel

Riveted construction of Econo-Mite 5 x 1.75-inch rubber-tired industrial wheel assures true alignment and facilitates installation of complete unit on all types of light portable equipment. Wheel has 2-in. hub length and ball bearings for ⅛ or 7/64-in. axle. The tire lugs are meshed into the wheel lugs to prevent tire slippage, and wheels are made to Tire and Rim Association standards. Manufacturer: Geneva Metal Wheel Co., 1055 Railroad St., Geneva, O.

For additional information circle MD 6 on Page 153

Weld-Nut



Having a standard square shape with four up-set projections on one face, this new weld-nut is particularly adaptable for assembly work which has one inaccessible side or where it is economical to avoid applying nuts in the conventional manner. Immediate deliveries of all standard sizes in unlimited quantities can be made. Manufacturers: The National Screw and Mfg. Co. and Lamson and Sessions, both of Cleveland, O.

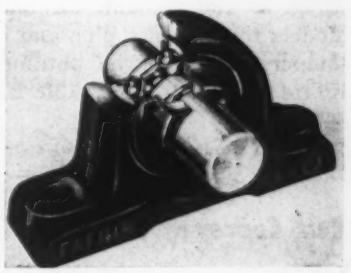
For additional information circle MD 7 on Page 153

Shock Absorbers

Permitting movement in all directions to assure maximum vibration absorption, these spring-loaded shock absorbers provide shockproof mounting for industrial lighting fixtures, fans, motors and other equipment. Unit consists of three cast iron parts and steel spring. Guide rims on stem prevent rotation, and spring seat collar at top prevents stem from passing through opening in spring plate under maximum spring compression. They are available in two junior and three heavy-duty sizes with load capacities of from 1½ to 80 pounds. Manufacturer: Thompson Electric Co., 1101 Power Ave., Cleveland 14, O.

For additional information circle MD 8 on Page 153

Pillow Blocks



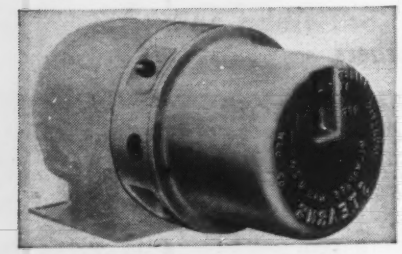
Available in nine shaft sizes ranging from 1 3/16 to 2 11/16 inches, LAO series pillow blocks are equipped with Mechani-Seal ball bearings which embody labyrinth type closure plus external slinger member to throw off contaminants when operating at normal speed. For added protection at low speeds or under adverse atmospheric conditions, combination synthetic rubber and felt washer has been incorporated as integral member of seal. Bearing has spherical outside diameter and spherical housing which provides unrestricted self-alignment in any direction. Housing in compact single piece reinforced at all stress points. Manufacturer: Fafnir Bearing Co., New Britain, Conn.

For additional information circle MD 9 on Page 153

Fractional HP Magnetic Brake

Disk type magnetic brake is suitable for use with electric motors in the 1/6 to ¾-hp range. Features of this Series X-60 brake include easily removed hous-

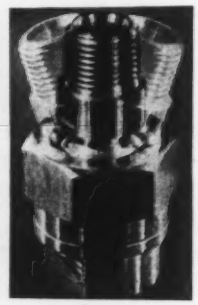
ing, straight-line solenoid pull, lining-wear indicator and ease of disassembly. Unit is recommended for continuous or intermittent duty on ac or dc. It is



adaptable to horizontal or vertical operation. Manufacturer: Stearns Magnetic Mfg. Co., Milwaukee 4, Wis.

For additional information circle MD 10 on Page 153

Swivel Pipe Joint Coupling

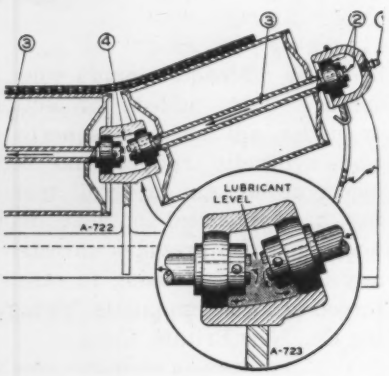


Capable of turning 20 degrees in any direction without restricting flow, universal swivel ball joint coupling absorbs vibration and movement in installations where pipe cannot be supported rigidly. Leakage and drip are eliminated by application of O-ring principle which provides positive seal against leakage at any pressure within unit's rating. Standard ⅜-inch joint can be used for pressures ranging from ¼ oz to 150 psi and for temperatures up to 350 F. Models for any size pipe and for higher pressures and temperatures can be obtained also. Manufacturer: Kelite Products, Inc., 130 Elmyra St., Los Angeles 54, Calif.

For additional information circle MD 11 on Page 153

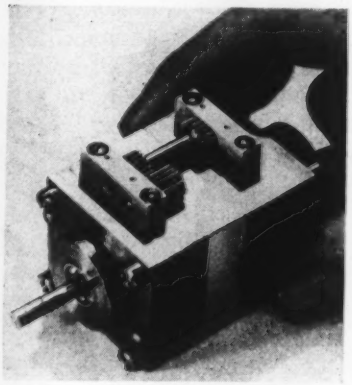
Belt Conveyor Carrier

Ease of service is feature of this line of Sealmaster ball bearing belt conveyor carriers. Removable rollers and bearing housings are quickly replaced or interchanged without tools. Six permanently sealed self-aligning ball bearing units, independent of their housing, are arranged for one-shot low-pressure lubrication from either side of carrier. Hollow live shafts and ball bearings turn with rollers to reduce friction and power requirement. One-piece welded steel frames are designed to tilt in direction of belt travel and keep belt centered within guide rollers. Inverted angle base and specially designed end brackets shed material and keep rollers free. Manufacturer: Stephens-Adamson Mfg. Co., 12 Ridgeway Ave., Aurora, Ill.



For additional information circle MD 12 on Page 153

Clutch-Brake Servomechanism

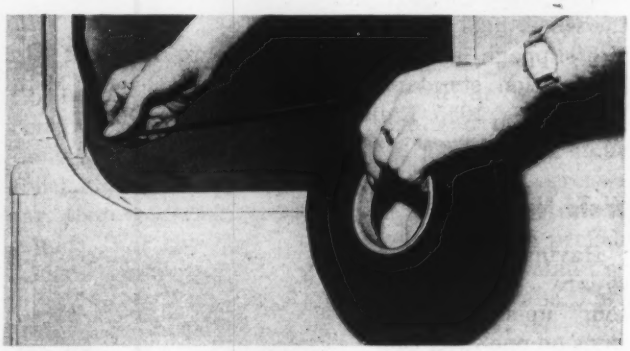


Use of the clutch-brake principle has enabled accurate servo performance with greater speed and torque outputs relative to servomechanisms of comparable size and weight. Input is supplied to side gearing, allowing for the stacking of several servomechanisms from one input shaft. Output is taken from the center shaft. Adaptable as a component for computers, aircraft, process control, remote positioning, and similar applications, the unit, model 183-1, is available separately or is furnished as a completely packaged servomachanism with suitable amplifier for operation from power sources of various frequencies and voltages. Manufacturer: Buehler and Company, 1607 Howard Street, Chicago 26, Ill.

For additional information circle MD 13 on Page 153

Protective Gasketing Material

Specially compounded and impregnated felt containing zinc chromate as a corrosion inhibitor, Chrome Lock is a protective gasketing material featuring such properties as: corrosion prevention, electrolysis prevention between dissimilar metals, flame resistance, nonoxidation, high compressibility and resistance to



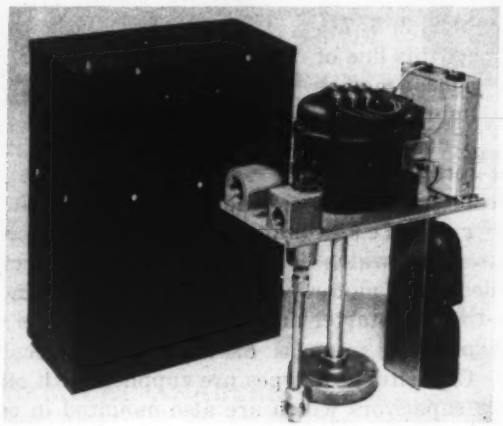
water and saline solutions. It has a pressure sensitive adhesive back for laying on all position surfaces. Variances in impregnation provide wide ranges of heat, cold and pressure resistances. Tapes, sheets or stampings are available in lengths of 100 ft with thicknesses of 1/32 and 1/16-inch, 50 ft with ⅛ inch, 25

ft with ¼-inch. Range of width is from 3/16 to 72 inches. Chrome Lock can also be supplied as a stamped gasketing to fit individual requirements. Manufacturer: Products Research Co., 5426 San Fernando Rd., Glendale, Calif.

For additional information circle MD 14 on Page 153

Condensate Disposal Unit

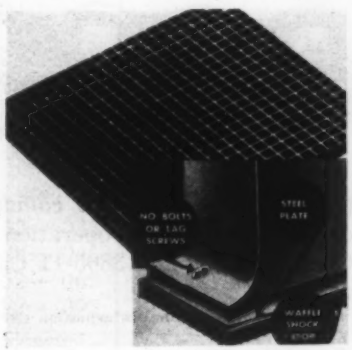
Providing efficient and trouble-free disposal of small quantities of condensate from air conditioning equipment, Model No. 2 condensate disposal unit features fully automatic control, compact rustproof construction, quiet operation and ball bearing electric motor. It is equipped with bronze centrifugal pump,



1½-gallon brass receiver, float-operated switch, check valve on outlet side of pump and is powered by 1/40-hp single-phase capacitor-start motor which operates on 115-volt 60-cycle current. Pump is capable of delivering 4¼ gpm at zero psi and has shut-off pressure of 12½ psi. Inlet is ¾-in. and outlet ½-in. pipe thread size. Manufacturer: Eastern Industries Inc., 296 Elm St., New Haven 6, Conn.

For additional information circle MD 15 on Page 153

Vibration Dampener



Vibrations set up by most types of motorized equipment can be easily isolated by placing Shock Stop rubber vibration dampeners with semi-pneumatic action between base of feet of equipment and floor or foundation. Tests show that where disturbing frequency is between 1000 and 3000 cycles per minute, reduction in vibrations of from 75 to 90 per cent can be obtained with these stops. They are available in 18 x 18-inch squares for cutting to required size or in rounds of either 2¼ or 3¼-inch diameter. Manufacturer: Connecticut Hard Rubber Co., 415 East St., New Haven 9, Conn.

For additional information circle MD 16 on Page 153

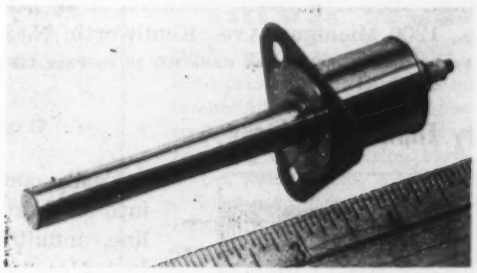
Solenoid Valves

Model 10041 is a normally-closed, two-way solenoid valve designed for continuous duty at ambient temperatures between −65 and +200 F handling air or fluids at pressures up to 12 psi. Weighing 0.44 lb, the valve's dimensions are: height, 3¼ in.; width, $1\frac{13}{32}$ in.; thickness, 1 in. Other models, both two-way and three-way, capable of handling fluids or gases at pressures up to 50 psi and operating intermittently at temperatures as high as 450 F are available. Slight modifications render these valves serviceable for continuous operation. Manufacturer: Carma Mfg. Co., 2401 E. 103 St., Los Angeles 2, Calif.

For additional information circle MD 17 on Page 153

Thermal Switch

Features of the Airite thermal switch are light weight, wide range of temperature adjustment, fast positive action, and long service life. Switch has a hermetically sealed stainless-steel housing and con-



tains no mica or plastics parts. It meets specification AS-401- Type III. Heart of the unit is a flexure pivot which is frictionless and nonwearing, assuring accuracy and dependability. Manufacturer: Airite Products Co., 3528 Union Pacific Ave., Los Angeles 23.

For additional information circle MD 18 on Page 153

Midget-Type Clamps

Designed for locating and holding small parts, series No. 250 midget-type clamps can be used as component parts of assembly fixtures as well as in drilling, milling, tapping and similar types of machin-

ing jobs. Clamps can be supplied with either soft bronze or heat-treated hard-chrome steel toe. Soft toe clamps are particularly useful for gripping finished or ground surfaces while secondary operations are performed. They can be obtained in three models,

each with different clamping arrangement: heel cam, center cam and hand-knob, designated as models CHAC-250, CCA-250 and HCA-250, respectively. Manufacturer: Noble & Stanton Inc., 724 Broadway, Bedford, O.

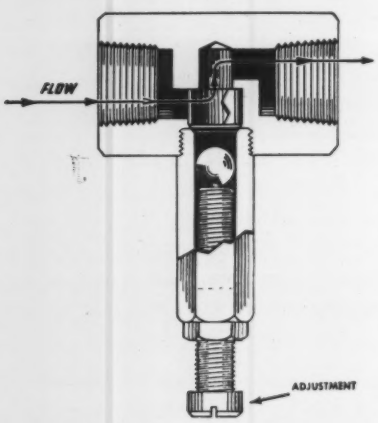
For additional information circle MD 19 on Page 153

Strain Relief Bushings

Accommodating small appliance wires, 2-P and 3-P nylon strain relief bushings act as insulating grommets which can absorb push, pull and torque to increase life and usefulness of product. They are made from duPont high temperature nylon and are Underwriters' Laboratories listed and approved. Applications include improving appearance and efficiency of electric clocks, fans, lamps, fractional-horsepower motors and similar devices. Manufacturer: Heyman Mfg. Co., 1200 Michigan Ave., Kenilworth, N. J.

For additional information circle MD 20 on Page 153

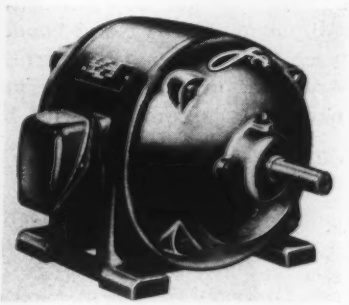
Velocity Limiting Valve



Easily connected into any air or gas line, infinitely adjustable velocity limiting valve instantaneously shuts off line flow whenever velocity or volume exceeds desired pressure setting up to 100 psi. In operation, stainless steel ball is pulled up against its seat and held in closed positon by line pressure whenever flow exceeds setting. When pressure diminishes, ball drops off its seat and resets itself. Screwing adjusting screw in or out of valve lowers or raises pressure setting at which valve closes. Valve is available in ¼-inch pipe size, with other sizes on special order, and is made of brass bar stock with stainless steel parts. Manufacturer: Pneu-Trol Devices, Inc., 3122 N. California Ave., Chicago 18, Ill.

For additional information circle MD 21 on Page 153

Single Phase Motors

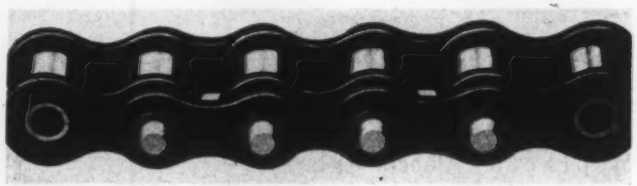


Available in capacitor-start induction-run types in ratings of 1 and 1½ hp, and in capacitor-start capacitor-run types in ratings of 2, 3, 5, 7½ and 10 hp, this line of single phase motors is of improved design. Centrifugal switch formerly used to disconnect starting condensers from line after motor reaches running speed is replaced by voltage relay which is mounted in control cabinet furnished with motor. Control cabinet also includes across-the-line starter and necessary capacitors which makes possible removal of capacitor enclosure on motor. Capacitor-run types are supplied with oil type running capacitors which are also mounted in control cabinet. Line includes open dripproof, splashproof, totally-enclosed, fan-cooled and explosion proof constructions. Manufacturer: Louis Allis Co., 428 E. Stewart St., Milwaukee 7, Wis.

For additional information circle MD 22 on Page 153

Detachable Roller Chain

Available in all sizes below ¾-inch pitch, detachable roller chain utilizes clip type retaining ring that fits into groove on pin. Having no extended



points, fastener cannot collide with other fasteners during chain drive operation. Manufacturer: Atlas Chain & Mfg. Co., 3805-11 Castor Ave., Philadelphia 24, Pa.

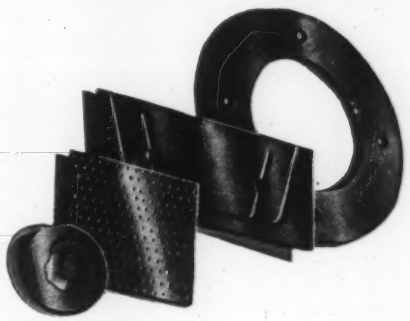
For additional information circle MD 23 on Page 153

Temperature Transmitter

Particularly useful for applications where it is desirable to have indication, record or control remotely located from point of measurement, Transaire with Speed-Act force-balance type pneumatic temperature

Sheet Metal Bearings-2

Pre-Cast Bronze-on-Steel



WHILE this is a comparatively new type of bearing material, developed and patented by Johnson Bronze, millions of bearings and parts now in constant use provide definite proof of its excellent qualities.

Pre-Cast Bearing BRONZE-ON-STEEL is essentially a thin wall, laminated type of bearing that combines the bearing qualities of a high grade bronze alloy with the strength of steel. We start with a mixture of copper, tin and lead which is universally accepted as the best general purpose bearing bronze available. It combines, in the correct proportion, all the necessary elements to insure the utmost in bearing performance.

By casting this alloy in solid bronze bars we unite the metals chemically and form a definite copper-tin eutectic—with the lead trapped in the interstices. Thus the grain structure of the alloy—and the resulting bearings—is definitely established. Next, we reduce the bronze bar to a fine powder, about the same consistency as talcum. This powdered bronze is then treated in a hydrogen furnace to remove all oxides and then firmly bonded to copper coated strip steel. The process of manufacturing bearings from BRONZE-ON-STEEL, in strip form, is the same as for any other type of sheet metal bearing, being essentially a stamping and forming operation.

Bearings are made from this material in the same manner as bronze sheet metal bushings. The range of wall thickness is between .031" to .110". Lengths of bearings cannot exceed 4½". The smallest I.D. which can be formed is ⅜". Steel thickness for .052" wall bushings is .036"; for .070" wall it is .050" thick.

BRONZE-ON-STEEL is assembled by the same methods ordinarily used for bronze metal. It can be burnished with ordinary tools. It is also possible to bore and ream this material, but special carbide tipped tools are necessary. Diamond boring is sometimes recommended as a finishing operation.

Chemical and Physical Properties of Bronze-on-Steel

CHEMICAL ANALYSIS	Plain Bronze	Graphited Bronze
Copper	Balance	Balance
Tin	8-11	8-11
Lead	8-11	8-11
Graphite	none	1.0 max.

PHYSICAL PROPERTIES

	(1) Rockwell Hardness E Scale	(2) Wear Rate	(3) Coefficient of Friction	(4) Resistance to Pounding	(5) Resistance to Pounding
Plain Bronze	55 min.	0.09	0.14	64	447
Graphited	55 min.	0.02	0.13	57	255

1. Rockwell Hardness, E scale 100 Kg. Load—⅛" ball.
2. Wear Rate Loss of weight in grams—1 hour run, 1" I.D. bushing at 400 R.P.M.—.005" clearance—25 lb. per sq. in. pressure—no lubrication.
3. Coefficient of Friction—as determined on J. B. Machine. No lubrication.
4. Resistance to pounding—number of blows of 60 lb. hammer falling 2" to deform specimen .001"—1" x 1" x 1/16" specimen.
5. Same as (4) with deformation going to .005".

Specifications

	Standard Wall Thickness	For Shaft Diameters
1.	.032—.035	From 5/16" to 1½" Shaft
2.	.042—.045	From ⅜" to 1¾" Shaft
3.	.062—.065	From ⅝" to 2¾" Shaft
4.	.092—.095	Over 1¼" Shaft

In order to obtain the best results from Pre-Cast Bearing BRONZE-ON-STEEL bushings and bearings, it is advisable to include the following information in your specifications:

1. SIZE of hole bushing is to be pressed into—rather than O.D. of bushings.
2. SIZE I.D. required after pressing into place. Manufacturers standard tolerance .002.
3. TYPE of body or housing bushing is pressed into.
4. SPECIAL FEATURES of bushing should be fully explained including their purpose.

Thrust Washers

While BRONZE-ON-STEEL was developed primarily for Bushings and Bearings it also fills many other important industrial uses. It is ideal for applications requiring a flat bearing surface such as plates, washers, etc.

Some manufacturers prefer to purchase BRONZE-ON-STEEL in rolls and do their own stamping and forming. For such cases we can furnish it in rolls up to 400 feet in length. The maximum width of the strip cannot exceed 6½ inches.

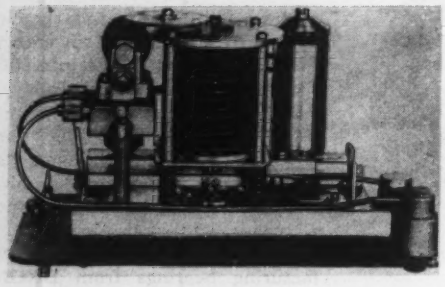
●

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze
SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

transmitter provides accuracy, high speed of response, small thermal elements and short range spans within limits of −375 to 1000 F. Incorporation of Speed-Act overcomes inherent lag present in response of thermal measuring element and improves quality of measurement of those elements requiring separable wells.

Transmitter is compact unit fully encased to provide adequate protection from dust and moisture. Its

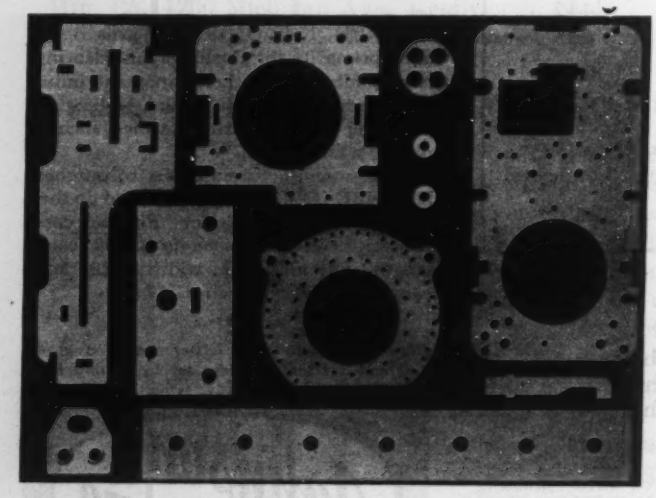


output in pounds per square inch is proportional to temperature of its thermal element; and by means of ¼-inch outside diameter copper tubing, this pressure change can be transmitted to recording or controlling receiver located as far as 1000 feet away. Convenient mounting brackets are provided for pipe or wall mounting, or adjustable bracket can be supplied when instrument is to be used with separable bushing. Manufacturer: Taylor Instrument Cos., Rochester 1, N. Y.

For additional information circle MD 24 on Page 153

Laminated Plastic

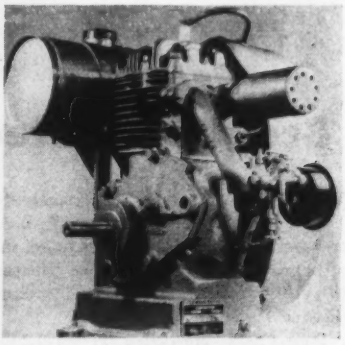
Adaptable for use in fine gears and other mechanical and electrical applications, RN-30 laminated plastic is said to have more uniform mechanical



strength, better machinability, smoother finish and better electrical properties than fabric-base laminated plastics now in common use. Matted, unwoven cotton fibers distributed evenly throughout result in uniform strength in all directions and a more desirable distribution of wear. Manufacturer: Formica Co., Cincinnati 32, O.

For additional information circle MD 25 on Page 153

Small Gasoline Engine

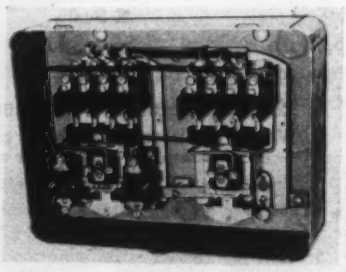


Husky air-cooled gasoline engines are now available for use as basic power units for all types of commercial and industrial equipment requiring four-cycle single-cylinder engine, clutch and transmission. Model M6 is rated 1.5-3.0 hp; model M7, 2.3-4.6 hp; and model M8, 2.8-5.2 hp. They can be supplied to operate in either direction of rotation and feature adjustable-taper main roller bearings, automotive precision type connecting rod bearings, adjustable flyweight type fully-enclosed governor and high-voltage magneto. Rope or kick starter can be furnished.

Manual positive-action, automatic and disk type clutches; transmissions with forward and reverse gears; and other accessories are available. Standard equipment includes dry type air cleaner, cylindrical muffler, 1-gallon fuel tank, bowl type gasoline strainer and Tillotson float fed carburetor. Manufacturer: Cushman Motor Works, Inc., Lincoln 1, Nebr.

For additional information circle MD 26 on Page 153

Magnetic Starters

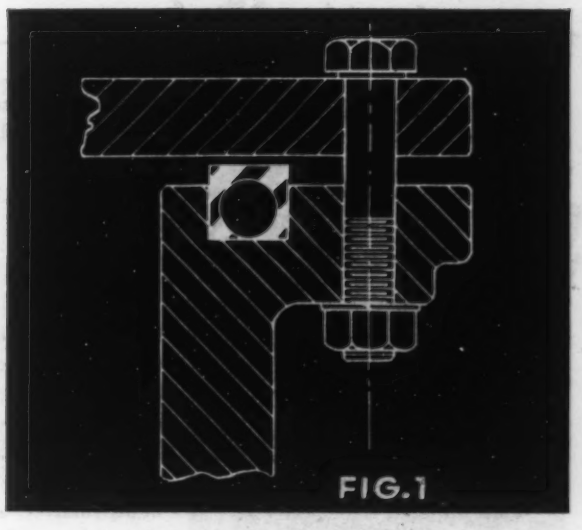


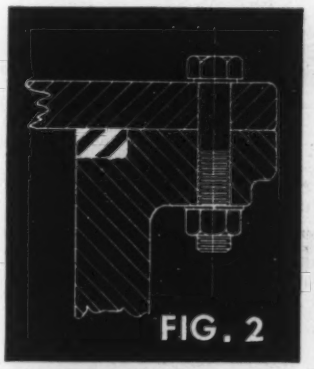
Available for across-the-line starting and for reversing of polyphase motors rated up to 200 hp on 550-volt 60-cycle current, line of three-pole alternating-current magnetic-reversing starters can be used for industrial control applications including drives for machine tools and woodworking machines and for inching, jogging or plug-stop service as well as direct reversing service.

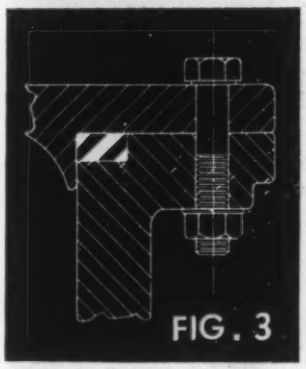
Four-pole starters with ratings of 7½ hp on 550-volt 60-cycle current are suitable for use with externally reversible single-phase motors of four-wire spilt-phase, capacitor or repulsion induction types.

Starters consist essentially of two magnetic contactors interwired for reversing operation, mechanically interlocked, and with or without thermal overload protection. Standard starters have sheet steel NEMA type 1 general-purpose enclosures, but on special order they can be furnished without enclosures

How to reduce sealing costs with truly compressible gaskets







Sealing costs often can be reduced by using truly compressible gaskets instead of special-section molded parts. Truly compressible gaskets usually are lathe-cut or die-cut to shape. Thus costly molds are eliminated and gasket-forming costs are reduced. And since these gaskets permit wider tolerances on recesses and mating parts, the cost of fabricating and assembling metal parts may be likewise reduced.

One such application is shown in figure 1. To illustrate why truly compressible gaskets permit wider metal tolerances, it shows the relative size of a round section, noncompressible ring and the equivalent truly compressible gasket made of Armstrong's cork-and-rubber. Compressing the extra thickness of cork-and-rubber obviously would compensate for much wider tolerance variations in metal parts.

The application in figure 2 utilizes the counterbore design to reduce fabricating costs. When molded rubber rings were tried, they tended to creep out of position. Cork-and-rubber, on the other hand, deforms mostly in the direction of the applied load. Hence, it remains firmly seated and provides an effective seal.

This type of construction can also be used to seal high internal pressures when altered as shown in figure 3. The controlled sideflow of cork-and-rubber provides a tight seal on both side and top. And the wider tolerances that are possible with Armstrong's cork-and-rubber rings hold sealing costs to a minimum.

Armstrong's cork-and-rubber can be made with natural or synthetic rubber. By adding calculated amounts of compressible cork to these noncompressible rubbers, Armstrong produces compounds in which sideflow is held within specified limits.

Versatile cork-and-rubber can help reduce your sealing costs. We suggest that you discuss your application with an Armstrong representative. He can suggest suitable materials and supply samples for your experimental use.

Send for this Gasket Handbook

You'll find useful application and specification data in the new, enlarged 24-page booklet, "Armstrong's Gasket and Sealing Materials." It contains up-to-date data on synthetic rubber, cork-and-synthetic-rubber, cork composition, and fiber sheet sealing materials.

This booklet includes ten technical discussions of the factors influencing modern gasket and joint design. It also suggests methods of putting Armstrong's stock materials to specialized uses in such fields as radio, electrical, automotive, petroleum, and transportation industries. Also included are typical applications and current government specifications.

For your free copy, fill in coupon at right and mail today.

ARMSTRONG'S
GASKETS · SEALS · PACKINGS

Cork Compositions • Cork-and-Synthetic-Rubber Compositions
Synthetic Rubber Compounds • Cork-and-Rubber Compositions
Fiber Sheet Packings • Rag Felt Papers • Natural Cork

ARMSTRONG CORK CO.
Gaskets and Packings Dept.
5107 Arch Street, Lancaster, Pa.

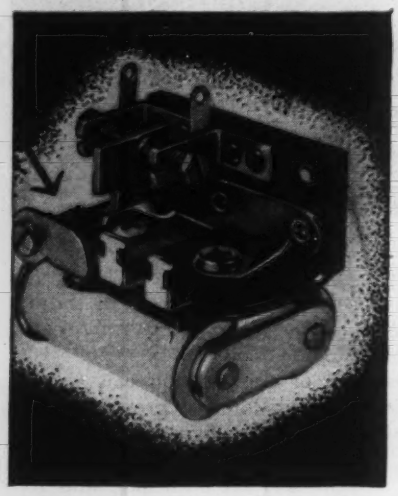
Please send me at once a copy of the new 24-page booklet, "Armstrong's Gasket and Sealing Materials."

NAME.....
COMPANY.....
ADDRESS.....
CITY.....STATE.....

for built-in or switchboard applications. Manufacturer: Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.

For additional information circle MD 27 on Page 153

Compensating Relay



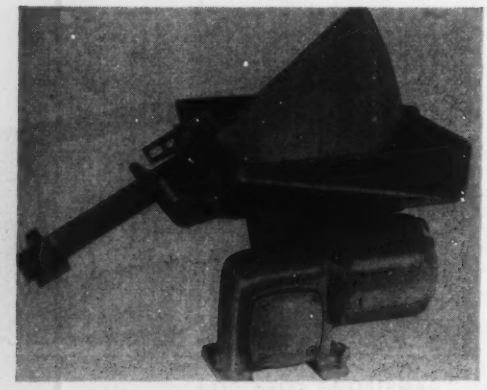
Developed for battery charger control where operating voltage must decrease with rising temperature, this temperature-compensated sensitive relay utilizes a bi-metal spring to provide voltage settings, stable within 1 per cent with 25 milliwatts operating power. Windings are available for all common charging voltages.

Same construction is also available in other relay types giving operation at essentially constant voltage at temperatures from −50 to 85 C. Adjustments are offered for voltages from 0.01-volt up, at sensitivities of 5 to 25 milliwatts. Manufacturer: Sigma Instruments, Inc., 45 Ceylon St., Boston 21, Mass.

For additional information circle MD 28 on Page 153

Automatic Hopper Feed

Feedall Model H-500 is a completely automatic, self-contained and driven hopper feeding unit. Cylindrical, headed or shouldered work from ⅛ to ⅜-in.

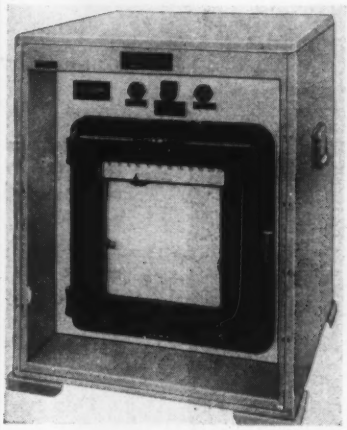


diameter and lengths of 4 in. can be handled. Powered by means of a ¼-hp gearmotor which also serves as the hopper mounting, the unit can be attached to centerless grinders, induction heaters, punch presses and many other special machines and fixtures. Old style wood screw shaving machines are made completely automatic by attaching the feed unit. Manufacturer: Feedall Machine & Engineering Co., 70 Vine St., Willoughby, O.

For additional information circle MD 29 on Page 153

Electric Pyrometer Recorder

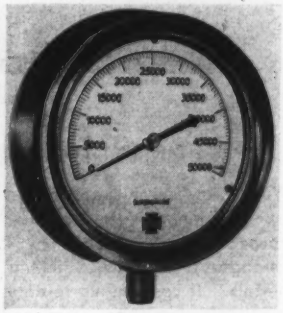
Fast-acting electric pyrometer recorder and controller can be used to control temperatures at six points simultaneously. Range covered is up to 2200 F. Unit may be used for semiautomatic control, for heat



cycling or for completely automatic heat-cycle program control. Cabinet measures 30 inches high, 24 inches wide and 22 inches deep. Weight is 100 pounds. Manufacturer: Electric-Arc Inc., 152-162 Jelliff Ave., Newark 8, N. J.

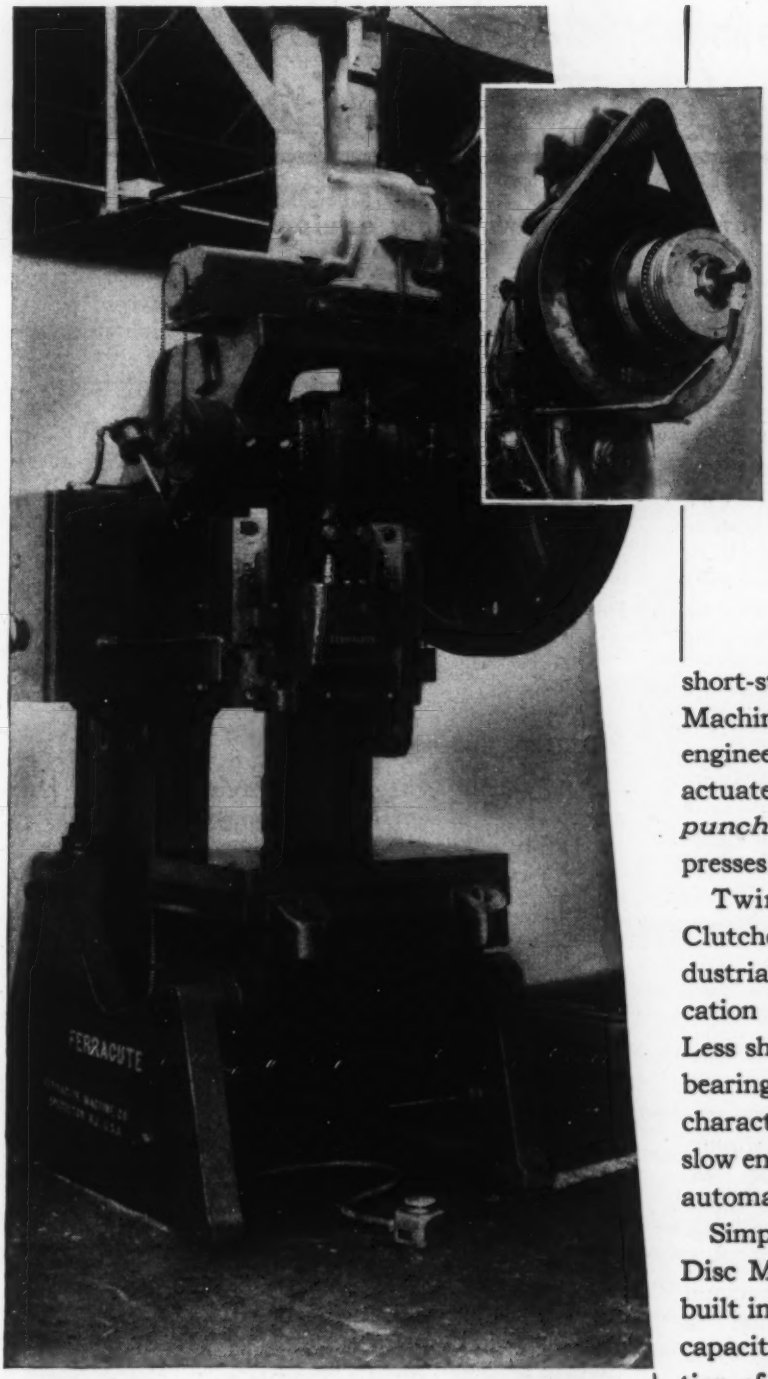
For additional information circle MD 30 on Page 153

High Pressure Gage



Designed for testing high pressure gases and liquids where gages are subject to extreme pressures as in manufacture of ammonia, hydrogen, nitrogen or in chemical and mechanical research, these gages have solid wall cast integrally with case to separate Bourdon tube and movement section from observer. Entire back of case is fitted with spring-mounted safety release. In event of tube rupture, safety release plate will momentarily discharge high pressure mediums away from observer. Bourdon tubes are beryllium copper or stainless steel and are threaded at both ends with full cut threads for interference fit. Gages have deep-bushed stainless steel geared movements of high ratio. Accuracy is 1 per cent of full scale reading on all pressures up to 50,000 psi and 2 per cent of full scale reading on all pressures of 60,000 psi and over. Manufacturer: United States Gage Div., American Machine & Metals, Inc., Sellersville, Pa.

For additional information circle MD 31 on Page 153



100% Faster Punch

Obtained from Twin Disc Model P Air-actuated Clutch

The problem was how to increase the short-stroke speed on a punch press. The Ferracute Machine Co., Bridgeport, N. J., called in Twin Disc engineers . . . who recommended Twin Disc Air-actuated Clutches. The result . . . *100% faster punch*. Now their complete line of 40 to 110 ton presses uses Twin Disc Air-actuated Clutches.

Twin Disc Models P and PH Air-actuated Clutches—standard on many types of heavy industrial equipment—offer advantages in any application where remote control operation is desired. Less shaft space is needed, permitting closer shaft bearing center distances. They have ideal operating characteristics: high torque capacity . . . fast or slow engagements . . . the ability to absorb heat . . . automatic adjustment for longer wear-life.

Simple in design, rugged in construction, Twin Disc Model P and PH Air-actuated Clutches are built in a wide range of sizes (14 to 42 inches) and capacities (75 to 1325 hp), permitting the selection of exactly the right clutch for every installation. Write for Bulletin 139-B. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

Ferracute 75-ton Punch Press equipped with Twin Disc Model P Air-actuated Clutch.

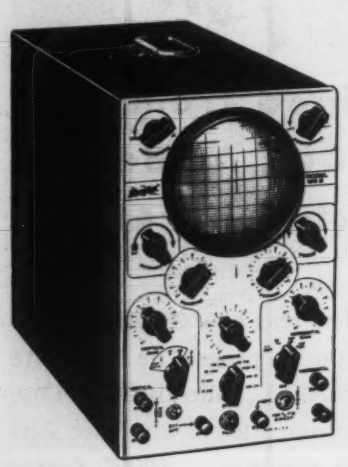
Close-up of Model P Clutch installed on Ferracute Punch Press.

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

engineering dept equipment

For additional information on this new equipment see Page 153

Oscilloscope



Designed for industrial and laboratory operations, sensitive model No. 195B, 5-inch oscilloscope is particularly suitable for analysis of transient phenomena. Unit has high gain amplifiers sensitive to 0.015-volt per inch on 30 cycles to 1 megacycle. Features include demodulator return eliminator, phasing control with sinusoidal sweep and 5UP-1 cathode ray tube. Manufacturer: Hickok Electrical Instrument Co., 10547 Dupont Ave., Cleveland 8, O.

For additional information circle MD 32 on Page 153

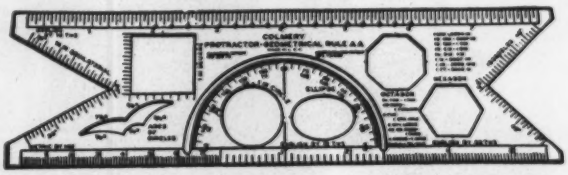
Repeat Cycle Timer

Obtaining its timing intervals by the charging of two resistance-capacitance networks, Model No. 1 repeat-cycle timer is an electronic device employing one radio type vacuum tube. Operation is such that one cycle initiates the next cycle without any moving parts or external operation. The off cycle is infinitely variable over a range of 0.1 to 60 seconds and the on cycle, 0.2 to 200 seconds. Standard relays make these intervals interchangeable. Power supply is 105-120 volt, 60 cycles; d-c timers are also available. Manufacturer: G. C. Wilson & Co., Chatham, N. J.

For additional information circle MD 33 on Page 153

Drafting Instrument

Colmery Protractor Geometrical Rule AA combines an English scale in 16ths of an inch, a metric scale in millimeters, an engineers scale in 10ths and 20ths, a protractor, 30 and 60 degree triangles and geometric-shape templates. Instrument measures 8½ inches long, 2½ inches wide and 0.060-inch thick and

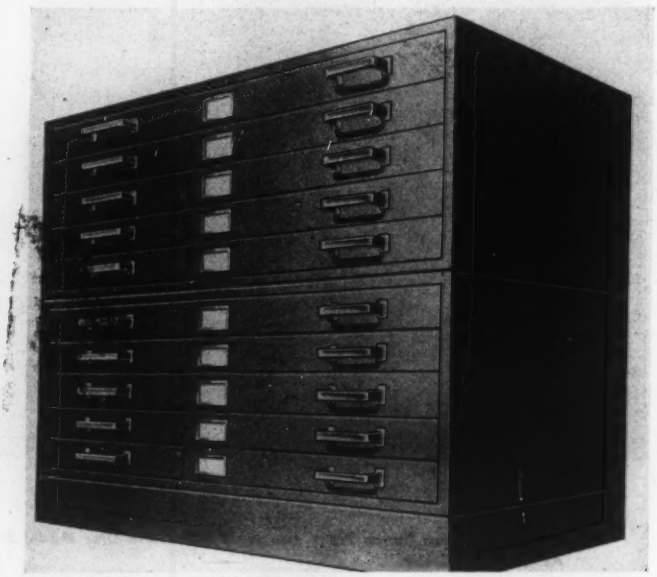


is made in various colors of plastic. Edges are beveled and markings are permanently indented. Manufacturer: Plastic Enterprise Inc., Canton, Ohio.

For additional information circle MD 34 on Page 153

Blueprint Cabinet

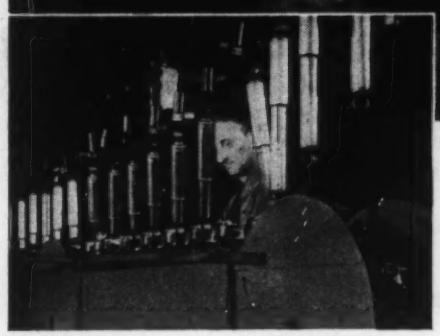
Solidly built of heavy gage furniture steel, blueprint cabinet is equipped with smooth gliding drawers on ball-bearing rollers and has lift compressor in



front of drawer and hood in rear to prevent material filed from curling, creasing or tearing. Cabinets can be used for artwork and photographs, blueprints, maps and plans, engravings and electrotypes, wall paper samples, swatches of textiles, leathers and paper stocks. They are supplied in olive green or gray crinkle finish, and five-drawer units can be stacked securely to meet individual requirements. Automatic plunger-type lock controlling all five drawers and 7½-inch base are available. Two sizes of cabinets can be obtained: one with inside drawer dimensions of 37 x 25 x 2¼ inches, and other with

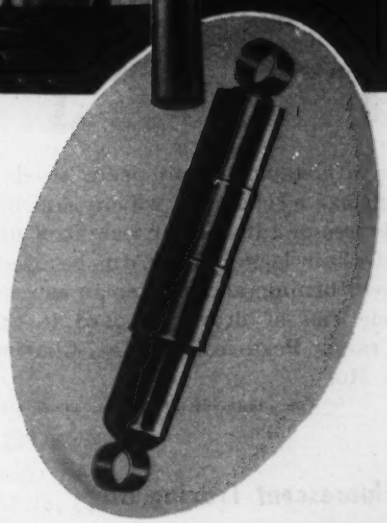
Houdaille-Hershey makes better shock absorbers *at lower cost* with J&L free-machining ELECTRICWELD STEEL TUBING

J&L STEEL



(*Above*) Multiple spindle broaching machine at the Houde Engineering Division of Houdaille-Hershey Corporation that machines the inside diameter of J&L ELECTRICWELD Tubing to 1/1000" tolerance.

(*Left*) Aeroplane-type shock absorbers on the production line at the Houde Engineering Division, Houdaille-Hershey Corporation, Buffalo, N. Y.



When production runs into thousands of units daily, every possible saving in material and labor costs in each shock absorber is vital to efficient manufacturing. Houdaille-Hershey Corporation, Buffalo, New York, reduced manufacturing costs when it changed from more expensive cold-drawn tubing to J&L *free-machining* ELECTRICWELD Tubing for the main cylinder of precision-built hydraulic shock absorbers.

This special J&L tubing is made from *resulphurized, open-hearth steel.* The resulphurizing imparts the desired free-machining quality required by Houdaille-Hershey for broaching the interior surface of the cylinders with uniform precision to a tolerance of 1/1000 of an inch.

Because J&L controls every step in the manufacture of ELECTRICWELD Tubing from raw materials to finished product, it can give you the exact grade of steel you need to help you make a better product, faster, and at a lower cost.

If you use tubing in the manufacture of your product investigate J&L ELECTRICWELD Tubing. Write today for your copy of our new booklet: "J&L ELECTRICWELD TUBING *for more strength with less weight.*"

Jones & Laughlin Steel Corporation
410 Jones & Laughlin Building
Pittsburgh 19, Pa.

Please send me your booklet: "J&L ELECTRICWELD TUBING *for more strength with less weight.*"

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

JONES & LAUGHLIN STEEL CORPORATION

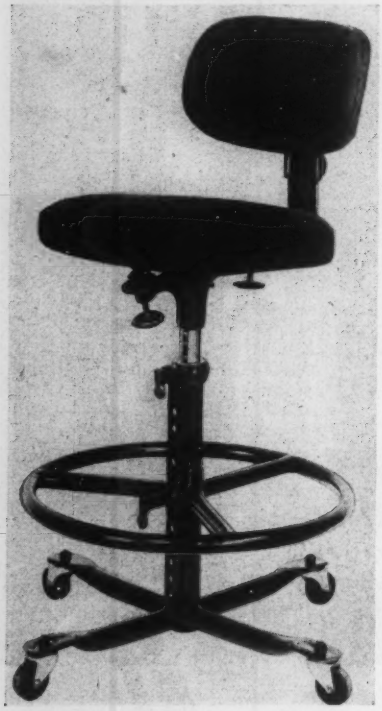
From its own raw materials, J&L *manufactures a full line of carbon steel products, as well as certain products in* OTISCOLOY *and* JALLOY (*hi-tensile steels*).

PRINCIPAL PRODUCTS: HOT ROLLED AND COLD FINISHED BARS AND SHAPES • STRUCTURAL SHAPES • HOT AND COLD ROLLED STRIP AND SHEETS • TUBULAR, WIRE AND TIN MILL PRODUCTS • "PRECISIONBILT" WIRE ROPE • COAL CHEMICALS

inside drawer dimensions of 43 x 32 x 2¼ inches. Manufacturer: Cole Steel Equipment Co. Inc., 285 Madison Ave., New York 17, N. Y.

For additional information circle MD 35 on Page 153

Drafting Chair

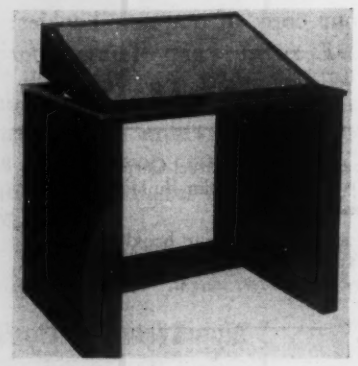


Completely adjustable without using tools, model 2422-TR drafting chair affords seating comfort to those working on drawing boards or tables. Height of seat can be adjusted easily in the range of 23½ to 32½ inches. Depth of seat can be changed by means of a handwheel to afford accommodation of individuals of any proportions.

Similar means is provided for fitting height of back to give posturized comfort. Footrest is adjustable to suit users' needs. Seat has forward-tilting mechanism which can be adjusted for any degree of tilt and for weight of user. Because of span of chair legs, casters can be used without danger of overturning, and draftsman can roll chair easily from one end of drawing board to other. Manufacturer: Cramer Posture Chair Co., Charlotte St., Kansas City 6, Mo.

For additional information circle MD 36 on Page 153

Fluorescent Tracing Unit

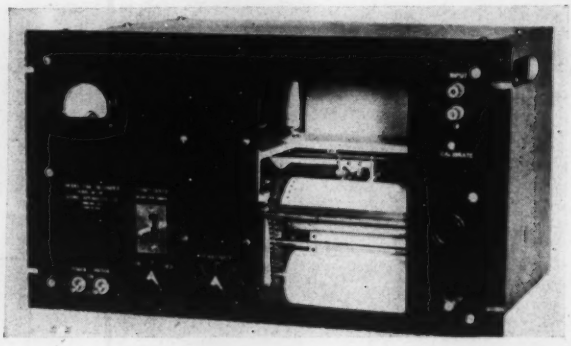


Made in two sizes, 20 x 24 and 24 x 36 viewing surface, these tracing units can also be furnished upon order in special sizes. All steel, they can be adjusted to the desired working angle and are equipped with 2 or 3 20-watt fluorescent lamps depending upon size. Underside of glass surface is sand blasted for better diffusion of light. Provided with extra long cord and switch, the tracing units are sold separately or with tables. Manufacturer: Stacor Equipment Corp., 1887 Atlantic Ave., Brooklyn 33, N. Y.

For additional information circle MD 37 on Page 153

Graphic Recorder

Model FRA graphic recorder is a direct ink-recording instrument which automatically plots a curve of any slowly or rapidly changing measurable quantity that can be converted into a d-c or a-c voltage. Measuring ranges can be selected and recorded either on a logarithmic or linear scale. Completely cased for portable field use or laboratory rack mounting in



10½ in. rack space, the unit incorporates built-in calibration control and is unaffected by voltage changes. It is available in 56 double chart-speed combinations from 45 inches per minute to ½-inch per hour and for recording frequency ranges from 2 to 200,000 cycles per second. Manufacturer: Sound Apparatus Co., Stirling, N. J.

For additional information circle MD 38 on Page 153

Vibration Meter

Self-contained, battery-operated with internal calibration requiring no external power connection, a new vibration meter is designed to read vibration levels directly in rms inches or rms inches per second when used with a suitable velocity pickup. No scale factor or conversion is required. Range is from 0.001 to 50 inches per second; 0.001-inch and up for displacement. Manufacturer: Calidyne Co., 751 Main St., Winchester, Mass.

For additional information circle MD 39 on Page 153

HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

70 Glass Fibers
Glass Fibers, Inc.—8-page illustrated booklet "Vitron Glass Fibers" discusses facilities and techniques used in production of glass fibers and explains characteristics of material which are of benefit to weavers, braiders and fabricators.

71 Steel Balls
Hartford Steel Ball Co.—20-page illustrated bulletin No. 241 gives data and prices of bronze, stainless steel, Monel metal and aluminum balls for bearings and other applications; burnishing balls and odd-shaped burnishing materials; silverware polishing mixture and cutting barrels.

72 Extruded Aluminum
Light Metals Corp.—6-page illustrated folder shows numerous aluminum extruded shapes and fabrications which can be produced to specifications and depicts steps in their production.

73 Belting
Manheim Mfg. Co. — 4-page illustrated pamphlet covers advantages and specifications of Veelos balata belting for power transmission, elevating and conveying. Tables show horsepower transmitted at different speeds, weights, thickness, breaking strength and list prices.

74 Retaining Rings
Ramsey Corp., Spiralox Div.—8-page illustrated catalog 201 shows how Spiralox retaining rings hold moving parts together. Test samples of these spring type retainers are offered. They snap readily into groove in shaft or in part and can be used for production line assembly. Wide range of sizes is listed.

75 Clutch
Conway Clutch Co.—16-page illustrated bulletin MGT gives design and performance data on medium sizes of gear-tooth-drive disk type clutches. Single and multiple plate clutches feature ease of engagement and adjustment, drag-free idling, dustproof enclosure, full length bearing and ample power capacity.

76 Electromechanical Counter
Engineering Research Associates, Inc.—2-page publication No. 122 depicts and describes ERA 1200 electromechanical counter that can be stacked to six digits and provides reliable carryover at operating speed of 1200 ccunts per minute.

77 Impact & Arbor Presses
Bellows Co.—8-page illustrated bulletin P-400 describes airpowered impact and arbor presses for riveting, staking, forming, pressing, stamping and other production operations. Specifications, operating and construction characteristics and safety controls are included.

78 Wire Cloth & Screen
Cambridge Wire Cloth Co.—85-page illustrated woven wire cloth catalog contains specifications, descriptions and data on meshes, weaves, metals and alloys included in this diverse line of industrial wire cloth, screens and metal products.

79 Stainless Steel Tubing
Babcock & Wilcox Tube Co.—6-page illustrated bulletin TB-323 discusses applications and advantages of stainless steel tubing in processing, transportation, and production industries. Various forms are discussed, and full specifications and properties of commonly used types are listed.

80 Moldings & Shapes
Dahlstrom Metallic Door Co.—166-page illustrated catalog No. 9 presents information on various cold rolled metal moldings and pressed shapes for general industrial uses as well as for architectural and building trades.

81 Nongranular Bronze
American Non-Gran Bronze Co.—4-page illustrated bulletin "Non-Gran Bronze Products" contains information on applications, physical characteristics and structure of nongranular bronze; presents table of stock bar sizes available and shows examples of both sand and centrifugal castings.

82 Valve Selector
Valvair Corp.—Selector made on principle of foreign language verb wheels gives code numbers for over 35,000 standard valves including knob, lever, foot, cam, treadle, cylinder, diaphragm and tandem-operated types. Price calculator is available also.

83 Hydraulic Valves
Gerotor May Corp.—52-page illustrated catalog section 201 describes over 90 models of four-way hydraulic valves. Included on each valve are working drawings, size specifications, cut-away views and operating diagrams of piston designs. Hand, foot, cam, solenoid, air pressure and oil pressure operated types are covered for pressures up to 1500 pounds per square inch.

84 Leather & Synthetic Packings
E. F. Houghton & Co.—4-page illustrated pamphlet "Packings by Houghton" presents information on Vim leather and Vix-Syn homogeneous and fabricated synthetic rubber packings for all hydraulic and pneumatic requirements.

85 Chrome-Nickel Steel
Eastern Stainless Steel Corp.—128-page illustrated reference and technical manual "Handbook for the Fabricator" gives not only complete description, analysis and other pertinent data on each type of chromium-nickel stainless steel but also shows how and where various types are used by industry.

86 Wheels & Hubs
Kelsey-Hayes Wheel Co., French & Hecht Div.—36-page illustrated catalog "Wheels and Hubs for Agriculture and Industry" gives details of sizes, types and applications of disk, cast iron and steel spoke wheels. Design data are included on wheel parts such as bolts, nuts, clamps, caps and lugs.

87 Industrial Finishes
Sherwin-Williams Co.—14-page booklet entitled "Implement Finishes" lists industrial finishes and their properties for use on farm, cotton gin machinery and earthmoving equipment. Included also are finishing systems for mechanized and nonmechanized equipment as well as finishing systems for different type metals.

88 Vibratory Bowl Feeders
Syntron Co.—2-page illustrated sheet entitled "Vibratory Bowl Feeders" describes how these units operate for feeding small cylindrical shaped objects in single file, one at a time. Sizes, shapes and various applications are listed.

89 Lubricants
Brooks Oil Co.—20-page illustrated brochure entitled "The Brooks Oil Story" presents picture trip through company's facilities for manufacturing lubricants for industrial use.

90 Electric Motors
Howell Electric Motors Co.—4-page illustrated bulletin SC-2 explains design and construction features of general purpose protected type electric motors.

91 Welded Tubing
Jones & Laughlin Steel Corp.—16-page illustrated booklet AD-64 presents uses and applications for electric welded steel tubing. Size and cutting tolerances are listed as well as bending and finishing data.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below.

FIRST CLASS
PERMIT No. 36
(Sec. 510 P.L.&R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed in the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Reader's Service Dept. CLEVELAND 13, OHIO

M. D. Numbers					
1	21	41	61	81	101
2	22	42	62	82	102
3	23	43	63	83	103
4	24	44	64	84	104
5	25	45	65	85	105
6	26	46	66	86	106
7	27	47	67	87	107
8	28	48	68	88	108
9	29	49	69	89	109
10	30	50	70	90	110
11	31	51	71	91	111
12	32	52	72	92	112
13	33	53	73	93	113
14	34	54	74	94	114
15	35	55	75	95	115
16	36	56	76	96	116
17	37	57	77	97	117
18	38	58	78	98	118
19	39	59	79	99	119
20	40	60	80	100	120

MACHINE DESIGN 7-49
Penton Building
Cleveland 13, Ohio

Please send literature or detailed information on subjects circled at left to—

NAME TITLE

COMPANY

MACHINES MANUFACTURED

ADDRESS

CITY AND STATE

This card MUST be completely filled out. Please TYPE or PRINT.

92 Beveled Retaining Rings

Waldes Kohinoor, Inc.—9-page illustrated manual EDR 1001 deals with use of Truare beveled retaining rings as means of eliminating end-play resulting from accumulated tolerances occurring in machine assemblies. Characteristics, engineering specifications, formulas and other data of interest to designers and engineers are presented.

93 Hydraulic Units

Vickers Inc.—8-page illustrated bulletin No. 38-14 describes double pump and combination valve unit which is suitable for powering hydraulic presses, plastic molding machines, clamping devices and machine tools which utilize traverse-and-feed cycles of operation. Displacements range from 5 to 45 gallons per minute and pressures up to 1000 pounds per square inch.

94 Blower Wheels

Jan-Air, Inc.—20-page illustrated bulletin No. 24-1 presents information on single and double inlet blower wheels of multiblade design. They move maximum volumes of air quietly, at relatively low speeds and with minimum of power input.

95 Ring Packing

Greene, Tweed & Co.—12-page illustrated technical bulletin TB-918 gives data on Palmetto G-T ring packing for use as seals in cylinders, swivel joints, struts and other applications including those where pressures are above current practices. Description of material, uses, test data, design and operational features and recommended dimensions are covered.

96 Hydraulic Pumping Unit

Sundstrand Machine Tool Co., Sundstrand Pump Div.—4-page illustrated publication No. 125 discusses WX hydraulic pumping unit for clamping, indexing and similar operations and which provides large volume of oil for rapid traverse of ram or other moving member and smaller volume at high pressure for actual work.

97 Compression Test Machine

National Forge & Ordnance Co.—4-page illustrated brochure 491 presents data on model TM 49001 compression test machine for recording stress and strain of containers. Machine has capacity of 5000 pounds for large volume production or laboratory testing. Capacity up to 10,000 pounds can be obtained by custom alterations.

98 Integral Horsepower Motors

Reliance Electric & Engineering Co.—8-page illustrated booklet presents latest selection data on company's integral horsepower alternating current motors. Torque and current standards in NEMA design classes A, B, C, D and F are tabulated and explained.

99 Thermosetting Resin

Valite Corp. — 4-page illustrated bulletin "Valite 8123" lists physical properties of laminates made with this black thermosetting resin. Developed from sugar cane, this material can be used in manufacture of laminates and laminated components.

100 Tantalum

Fansteel Metallurgical Corp.—20-page illustrated bulletin entitled "The Metal Tantalum" tabulates physical, chemical and electrical properties of this metal which is almost completely immune to corrosion or chemical attack. Methods of fabrication and typical uses of this material are outlined.

101 Engine

Allis-Chalmers Mfg. Co.—8-page illustrated bulletin MS-423 is descriptive of model U318 power unit which can operate on gasoline, low grade fuels such as kerosene and distillate, and on natural gas. Engine develops 45 brake horsepower at 1200 revolution per minute and is available in standard, open and outboard bearing styles of mountings.

102 Motor Controls

Trumbull Electric Mfg. Co.—22-page illustrated bulletin TEB 8 announces a new line of magnetic motor controls which afford full protection against damage from overload and under-voltage to alternating current motors up to 50 horsepower.

103 Ethyl Cellulose

Hercules Powder Co.—Illustrated technical booklet "Ethyl Cellulose, Properties and Uses" contains latest data on this cellulose derivative which can be formulated into plastics, lacquers, varnishes, film, foil and adhesives. Properties, formulation and applications are covered.

104 Contour Forming Machine

Cyril Bath Co.—6-page illustrated publication "Combining Stretch and Contour Forming" describes process for reducing or eliminating handwork in contour forming operations. Processes handled by machine, typical parts formed and points to consider in selecting a contour forming machine are presented.

105 Protective Coatings

Koppers Co.—12-page illustrated folder entitled "Koppers Industrial Protective Coatings" gives expert direction on application of cold-applied protective coatings especially designed to prevent corrosion and deterioration.

106 Metal Processing Facilities

Geuder, Paeschke & Frey Co.—4-page illustrated folder "For Your Contract Requirements of Metal Products and Components" discusses facilities for engineering, designing, stamping, drawing, forming, all types of welding, tinning, galvanizing, lead coating, vitreous enameling and spray painting.

107 Aircraft Hydraulic Equipment

Aeroquip Corp.—52-page illustrated catalog No. 200 gives complete engineering and installation data and specifications on flexible hose lines, hose fittings, self-sealing couplings and the Aeroquip Hydrofuse. Included also is detailed information on Hydrauliscope, an instrument used in research laboratories to measure pressure phenomena.

108 Piping Color Code

Globe Steel Tubes Co.—4-page illustrated bulletin No. 400 is entitled "Color Code for Identification of Stainless Steel Tubing and Pipe". Recommended banding is shown in actual color.

109 Alloy Castings

Michiana Products Corp.—16-page illustrated booklet No. 111 lists compositions, properties and applications of heat resistant alloys, stainless steel, Ni-Resist and abrasion resistant alloy castings. High temperature fans are also described.

110 Hard Surfacing

Lincoln Electric Co.—16-page illustrated bulletin No. 466 is guide to proper arc weld surfacing. Listed are correct electrodes for specific requirements as well as various design and production aids.

111 Pneumatic Control Devices

Westinghouse Air Brake Co.—8-page illustrated catalog IDA 9481-1 lists pneumatic control devices and accessories for industrial applications and shows installations that assure correct performance.

112 Electric Motors

B. A. Wesche Electric Co.—8-page illustrated bulletin "Welco Custom Built Torque Motors and Collector Rings" lists design and performance features of these motors which are built to user's requirements. Typical designs and available mountings are shown.

113 Pressure Castings

Meehanite Metal Corp.—12-page illustrated bulletin No. 10 "'Meehanite—the Metal for Pressure Castings" describes and illustrates variety of applications of Meehanite castings in cases where high pressures are required and states five primary advantages of the metal in this field.

114 Fluid Drives

American Blower Corp., Hydraulic Coupling Div.—4-page illustrated bulletin 8019 describes type VS Class 6 Gyrol fluid drive for 3600-revolution per minute boiler feed pump. Performance characteristics are shown.

115 Spring Data

Illinois Coil Spring Co.—Illustrated booklet "Brief Guide for Spring Buyers" explains principal types of springs and their applications, various types of spring ends and other data.

116 Projection Papers

Eastman Kodak Co.—8-page illustrated catalog F3-13 lists various Kodagraph projection papers for use in enlarging, reducing and restoring line drawings, printing and writing.

117 Molybdenum Cast Steels

Molybdenum Corp. of America—20-page catalog "Molybdenum Cast Steels" discusses metallurgical effects of molybdenum in cast steel. Included are foundry methods for various alloys containing molybdenum, applications and results obtained.

118 Electrical Timing Devices

A. W. Haydon Co.—10-page illustrated catalog "Preferred Where Performance Is Paramount" contains materials on principles of operation, performance characteristics, timing ranges, construction details, applications and special features of line of electrical relays, timers, switches, indicators and motors.

119 Brazing Alloy

Westinghouse Electric Corp.—15-page illustrated booklet B-4198 discusses extruded Phos-Copper as uniform brazing alloy for copper, brass and bronze. Described are eight methods of brazing with this material.

120 Insulated Wire & Cable

General Electric Co.—16-page illustrated manual GEA-4352 tells story of style FL Flamenol insulated wire and cable for wiring machine tools, appliances, chemical processing equipment and other low-voltage electrical apparatus. Cable is slow to age, flameproof and resistant to acids, oils and alkalies.

M. D. Numbers

1	21	41	61	81	101
2	22	42	62	82	102
3	23	43	63	83	103
4	24	44	64	84	104
5	25	45	65	85	105
6	26	46	66	86	106
7	27	47	67	87	107
8	28	48	68	88	108
9	29	49	69	89	109
10	30	50	70	90	110
11	31	51	71	91	111
12	32	52	72	92	112
13	33	53	73	93	113
14	34	54	74	94	114
15	35	55	75	95	115
16	36	56	76	96	116
17	37	57	77	97	117
18	38	58	78	98	118
19	39	59	79	99	119
20	40	60	80	100	120

MACHINE DESIGN 7-49
Penton Building
Cleveland 13, Ohio

Please send literature or detailed information on subjects circled at left to—

NAME _____ TITLE _____

COMPANY _____

MACHINES MANUFACTURED _____

ADDRESS _____

CITY AND STATE _____

This card MUST be completely filled out. Please TYPE or PRINT.

FIRST CLASS
PERMIT No. 36
(Sec. 510 P.L.&R.)
Cleveland, Ohio

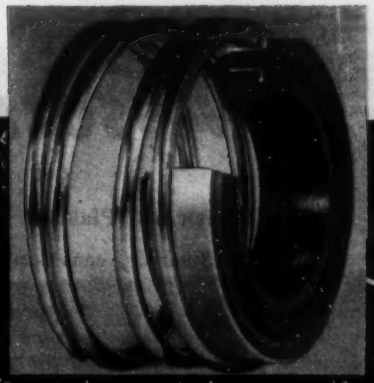
BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY—

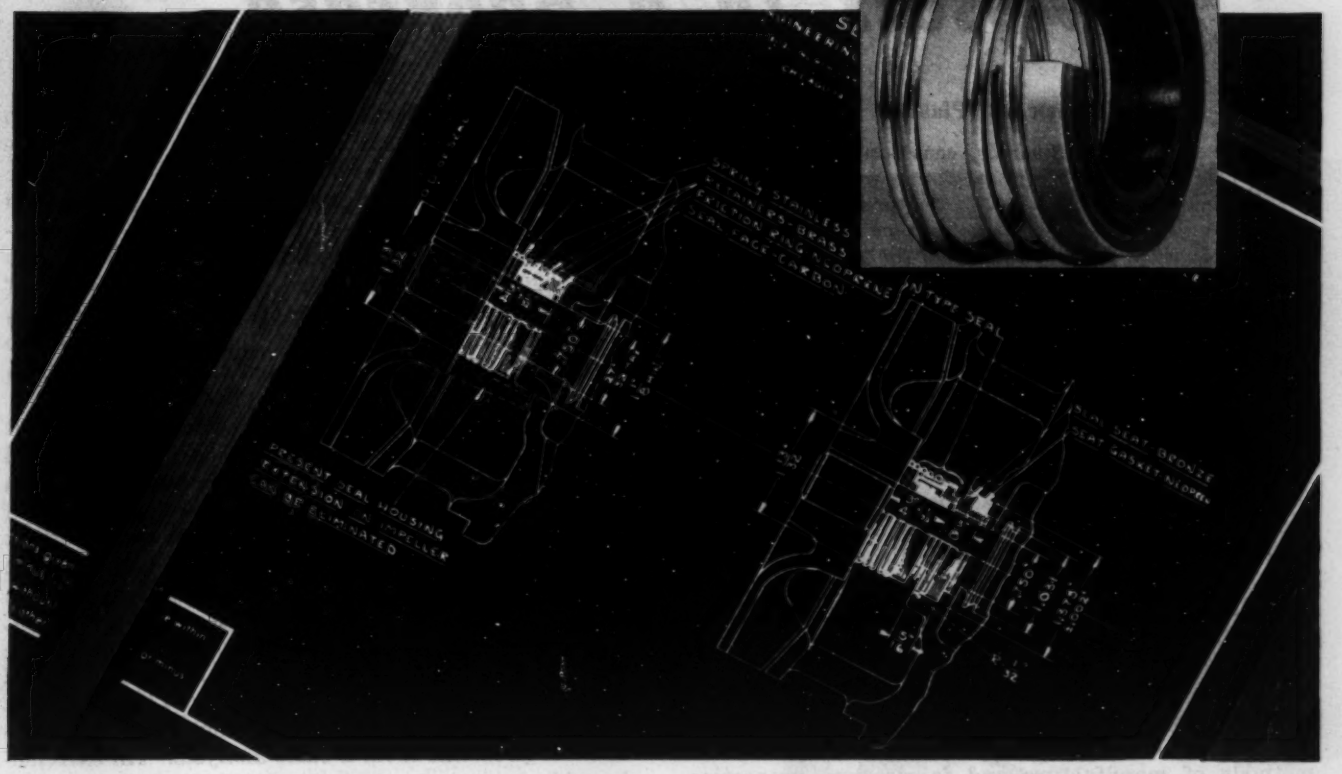
MACHINE DESIGN
Penton Building
CLEVELAND 13, OHIO

Reader's Service Dept.

NEW TYPE "N" ROTARY SEAL



PAT. APPL. FOR



engineered for new *Production-line* efficiency

Type "N" Rotary Seal eliminates "watchmaker" assembly jobs, by providing the Seal pre-assembled and ready to incorporate into the equipment. This unit construction means no loose parts to deal with—no delicate adjustments or fittings to make. In short, Type "N" Rotary Seals are thoroughly efficient production-line adaptations of a time-tested principle, worked out especially to meet the increasingly difficult sealing problems brought about by higher shaft speeds or adverse lubrication conditions.

Rotary Seal engineers can quickly adapt this new Seal to any of a wide range of applications. Inasmuch as Type "N" has been designed particularly to meet mass production conditions, it is not available in small quantities for all shaft sizes.

THE ROTARY SEAL PRINCIPLE

is the original approach to a practical solution of a universally troublesome problem. Our booklet "Sealing with Certainty" explains and illustrates the principle. We're glad to send it to you without obligation. Full description of Type "N" is included.

THE ROTARY SEAL COMPANY
mechanical seals for rotating shafts

SEND FOR YOUR COPY TODAY

Assets to a Bookcase

Handbook of Plastics

By Herbert R. Simonds, consulting engineer; Archie J. Weith, former director of research and development of the Bakelite Corporation; M. H. Bigelow, director of technical service of the Plaskon division of Libby-Owens-Ford Glass Company; published by D. Van Nostrand Co. Inc., New York; 1511 pages, 6½ by 9½ inches, clothbound; available through MACHINE DESIGN, *$25.00 postpaid.*

The term plastics is too young to be privileged with an unchallenged definition. The application of plastics, however, is not too infant to enjoy a seemingly boundless range. This broad scope necessitates an exhaustive coverage of every phase of the industry organized for instant reference. Prompted by this need, the authors have prepared a second edition of their handbook which in entity is practically a new book.

This second edition is a comprehensive observance of plastics from the raw material to the finished product and then to the sales organization of many prominent companies. It covers fully the composition, methods of manufacture and fabrication, properties and uses of all plastics—those that have already reached tonnage production, as well as those closer to the pioneer stage. It has complete discussions on the new fibers, new organic coatings and adhesives, and new laminating materials and synthetic rubbers. Other chapters cover new processes and methods of fabricataion, and present business facts and economic trends.

A compilation of a vast quantity of data, the book forms a complete library on plastics under one cover, replete with information on the old plastics with their new applications and those progressive developments presently being translated into commercial use.

□ □ □

Elements of Mechanical Vibration

By C. R. Freberg, head of the Engineering Division of the Southern Research Institute, and Emory N. Kemler, assistant director of research and research professor of mechanical engineering at New York University; published by John Wiley & Sons Inc., New York; 227 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, *$3.75 postpaid.*

Failure of machinery parts, loss of mechanical efficiency or objectionable noise and motion are, in many cases, directly attributed to vibration. Designers and engineers can create truly effective equipment only if they consider this vital factor.

Although there are many problems in the field of vibration which can be solved only by using the methods of advanced mathematics, there are also many problems which can be solved by using the simpler forms of differential equations, approximate methods developed, or the mobility method which algebraically finds relative and absolute displacements, velocities, accelerations and forces at any point in the system and also makes the handling of damping comparatively simple. Purpose of this book is to discuss in detail the more elementary phases of vibrations and reduce them to a form in which they can be applied to practical problems.

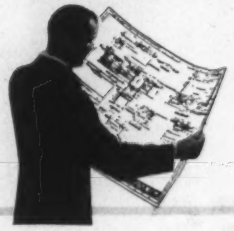
This second edition is distinguished from the first by the addition of two chapters, "Sound" and "Beams", and several minor additions and corrections necessary to comply with latest developments and needs. Increased emphasis which engineers must give to noise elimination led to the inclusion of the chapter on sound and its engineering applications. Since beams are a very common structural element, they have been given additional emphasis by combining the previous discussion with new material and presenting it as a separate chapter. Like the first edition, this book lays great stress on the simple treatment of problems from a basic analysis. An extremely wide range of problems, detailed explanation of various phases of vibration and formulas and directions for their use are presented.

All of these features combine in a book that helps the student and engineer to solve practical vibration problems with a minimum of complication.

The American Society of Lubrication Engineers inaugurates a publication program, designed to make available in convenient form fundamental knowledge of lubrication, with the preparation of a 72-page booklet containing an accurate and complete survey of the basic phenomena of lubrication. *Physical Properties of Lubricants* is devoted to a rather complete coverage of viscosity, density and specific gravity, cloud and pour points, flash and fire points, carbon residue, neutralization number, interfacial tension, saponification number, emulsification, and specific heat. The ten chapters are replete with tables, charts, diagrams, and informative discourses. The booklet is available from The American Society of Lubrication Engineers, 343 South Dearborn St., Chicago 4, Ill., for $1.50.

Bibliography on X-ray Stress Analysis by Herbert R. Isenburger is a combination of X-ray method, subject index, and bibliography presented in 17 mimeographed pages. More than 200 references on all phases of X-ray are listed. Booklet is available from St. John X-Ray Laboratory, Califon, N. J. for $3.00.

Designed for industrial microfilming requirements



. . . Kodagraph Micro-File Equipment

TO CONDENSE, PRESERVE, PROTECT YOUR DRAWINGS . . . THE KODAGRAPH MICRO-FILE MACHINE

Place an engineering drawing on the copyboard . . . touch a foot-switch . . . and the machine does the rest—

Instantaneously, it takes the picture at great reduction . . . advances the film . . . is ready for the next drawing.

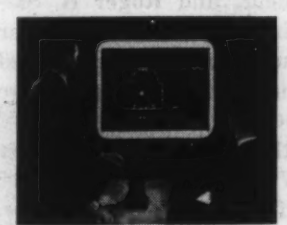
In this manner you can record documents—large or small—bound or unbound. Do it conveniently . . . speedily . . . whenever the demand arises.

4 different models now available

Kodagraph Micro-File Machines meet the wide range of requirements in engineering departments . . . and in the field. Each is a precision machine . . . designed by Kodak . . . made by Kodak to give you these advantages—

- You can reclaim 98% of your filing space . . . microfilm old records . . . then destroy them, if you wish.
- You can provide branch offices, repair depots with compact, duplicate records on positive microfilm.
- You can simplify reference work . . . file your 16mm. or 35mm. film records at your finger tips . . . ready for immediate review in the Kodagraph Film Reader.

To view your microfilm records in the office . . . the Kodagraph Film Reader. Each image is enlarged sharp and clear . . . easy to read and check . . . on a special green-tinted viewing screen. You can speed the film from image to image . . . get all the information you need—quickly.



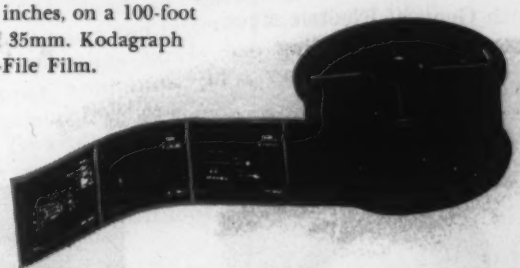
To view your microfilm records in the field . . . the Kodagraph Portable Projector. You can flash your records on any screen or light colored wall . . . magnified at dimensions up to several times larger than the original, if necessary. It is convenient to carry—weighs only twelve pounds.

To make enlargement prints from your microfilm records . . . the Kodagraph Micro-File Enlarger. It produces prints of maximum legibility . . . so sharp that they can be used as intermediates in direct process or blueprint machines.

"Kodak" is a trade-mark

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.

In weighing the advantages of installing a Kodagraph Micro-File Machine in your engineering department . . . consider, too, the economy of the operation. You can record 675 drawings, size 24x36 inches, on a 100-foot roll of 35mm. Kodagraph Micro-File Film.



For complete information, write today for illustrated literature.

19

Eastman Kodak Company
Industrial Photographic Division
Rochester 4, N. Y.

Please send your literature illustrating Kodagraph Micro-File Equipment.

Name _____ (please print)

Department _____

Company _____

Street _____

City _____

State _____

Kodak

Men OF MACHINES

A. P. Olches has been recently appointed chief engineer of Peabody Engineering Corp., New York City. A graduate of Stevens Institute of Technology he joined Peabody Engineering in 1928, advancing rapidly to manager of research and development. As chief engineer he will continue to direct the engineering and research of the company. Announcement has also been made of the appointment of **Robert C. Vroom** as executive adviser and consultant. Also a graduate of Stevens Institute of Technology, Mr. Vroom held the position of chief engineer for many years. In his new capacity he will concentrate on all phases of the company's activities.

A. P. Olches

J. C. Rhoads has recently been made division engineer of General Electric Co. Locomotive Engineering Division, succeeding **A. J. Woodward,** who has retired. Mr. Rhoads has been with General Electric since 1934. After spending one year as a test engineer, he took G. E.'s advanced engineering course for three years, during which time he worked on special assignments in the refrigerator unit factory and the company's research laboratory at Schenectady. Transferring to the Erie Works in 1937, he was assigned to the mechanical design section of the motor engineering division and four years later became section engineer. He remained with the motor engineering division until late 1945 when he transferred to the locomotive engineering division as assistant to the division engineer, which post he held until his recent appointment.

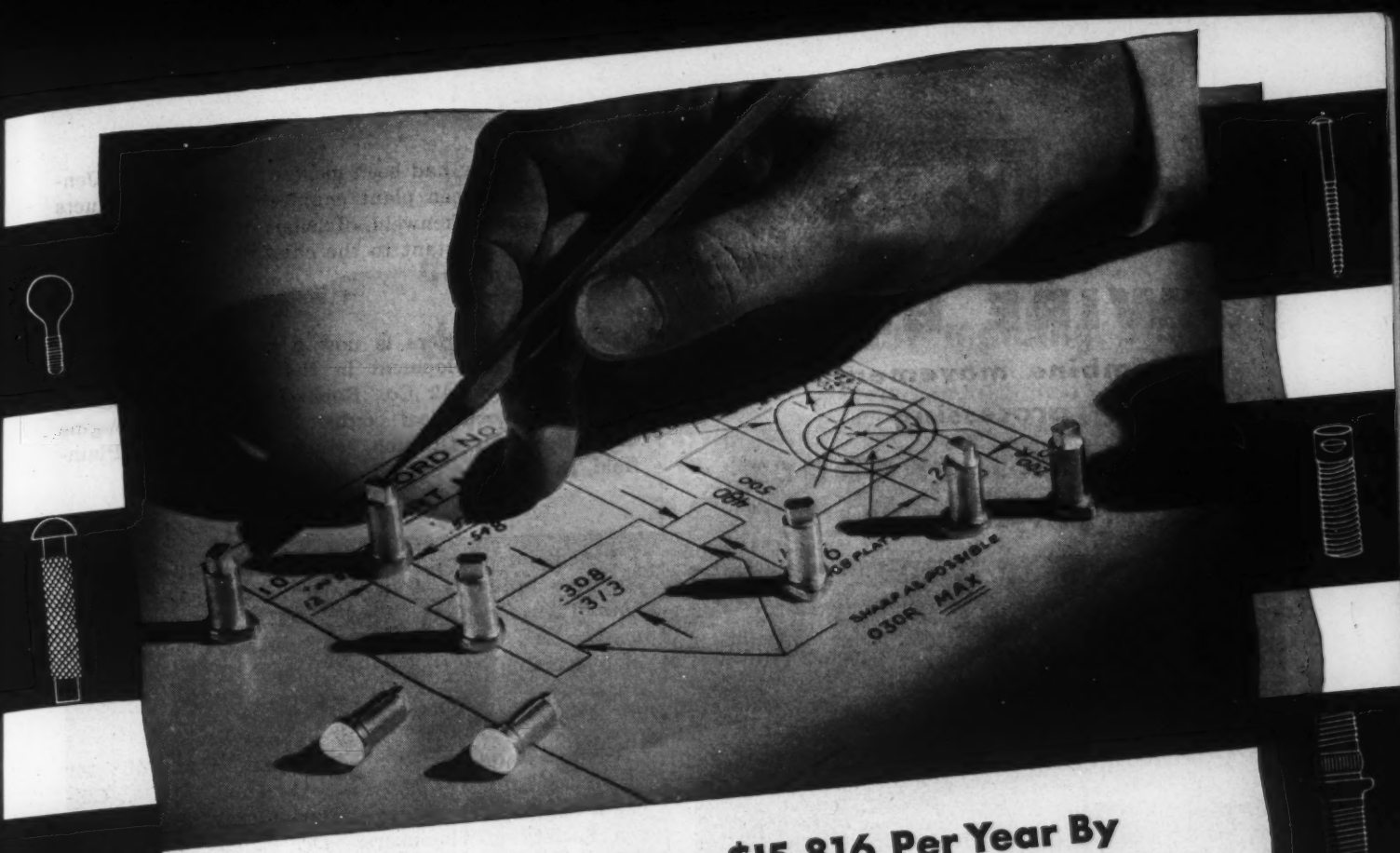
J. C. Rhoads

F. W. Walker

F. W. Walker, executive vice president of the Philadelphia Gear Works Inc., Philadelphia, was elected president of the American Gear Manufacturers Association at the recent annual meeting. He has been active in AGMA affairs for a number of years, having served on numerous committees, and for the past year has been vice president of the association. At the same meeting **Leroy Brooks, Jr.,** president of Tool Steel Gear and Pinion Co., Cincinnati, was elected vice president, and **Roger B. Salinger,** president of the Massachusetts Gear and Tool Co., Woburn, Mass., was re-elected treasurer. New members of the executive committee are: **George H. Sanborn,** chief field engineer of the Fellows Gear Shaper Co., Springfield, Vt.; **Robert B. Moir,** vice president and chief engineer of Foote Bros. Gear and Machine Corp., Chicago; **Paul W. Christensen,** president of Cincinnati Gear Co., Cincinnati; and **George H. McBride,** sales manager of the Nuttall Works, Westinghouse Electric Corp., Pittsburgh.

♦

Announcement has been made of the appointments of **Harry A. Fohl** as chief engineer and **Neils H. Jensen** as assistant chief engineer of Lukens Steel Co. Mr. Fohl, who has been assistant to the chief en-



Reid Products Saves $15,816 Per Year By Using One Townsend Cold-Headed Part

The little cam above is doing the job of a more expensive part and doing it just as well. The Reid Products Division of Standard Products Company of Cleveland wanted this part for an automobile door lock assembly but found it would cost $38.50 per 1,000 if produced on automatic screw machines. The same part, with its close tolerance and eccentric shape, is being cold headed and cadmium plated for them by Townsend Company for only $25.32 per 1,000. This clear saving of $13.18 per 1,000 becomes mighty important at the rate of 100,000 parts per month. It adds up to $15,816 per year.

This is just one example of the way Reid Products has been cutting production costs by working with Townsend engineers. Other items are being made for them at savings of $.70, $10.01, and even as much as $21.97 per 1,000. These are typical examples. Some Townsend customers save more.

Designers who seek ways to reduce costs find it pays to call on Townsend for small parts. They can be cold headed, pointed, machined, drilled, slotted, trimmed, roll threaded, extruded, pierced, knurled, bent or flattened. Townsend makes parts and fasteners in carbon, alloy and stainless steels—in brass, bronze, copper, aluminum—in a variety of platings and finishes.

To find out how to reduce your costs on small parts send Townsend a sample or sketch. Our engineers will gladly give you an estimate without obligation.

Call or write today to:

Townsend

COMPANY — ESTABLISHED 1816

New Brighton, Pa.

Chicago 38, Ill.

There's a Cambridge

WIRE BELT

to combine movement with processing

for EVERY PRODUCT

. . . or MATERIAL

A Cambridge Balanced Belt safely and speedily carries clock faces through the decorating lehr. In a modern ceramics plant, Cambridge belts can also be used for annealing and glazing. Open mesh permits free heat circulation around the ware. Moving belt eliminates use of cars or saggers.

Whether your product is big and bulky or small and fragile, if it must move during processing or production, a Cambridge Woven Wire Conveyor Belt can do the job economically and safely.

Woven from any metal or alloy to any mesh or weave, Cambridge belts offer dependability, long life, freedom from time-wasting shutdowns for repairs. Among the specially designed Cambridge belts in service today are continuous conveyorized installations for baking, quenching, tempering, washing, drying, cooling and packaging.

Whenever you have a problem concerning movement during processing, call in a Cambridge Field Engineer.

Or, for complete information on the entire Cambridge line, write today for your FREE copy of this 130 page illustrated book. Gives belt and conveyor design, applications, installation data, construction details. Write today . . .

There's a Cambridge Sales-Engineering Office near you!

Cambridge Wire Cloth Co.

Wire cloth in rolls. Also specialized wire fabrications

Dept. N
Cambridge 7, Md.

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

gineer, formerly had been master mechanic. Mr. Jensen, who had been plant engineer with By-Products Steel Co. and Lukenweld, divisions of Lukens, formerly had been assistant to the chief engineer.

♦

Wilson G. Walters is now a mechanical engineer on product development in the Hawk-Eye Division of Eastman Kodak Co., Rochester, N. Y. Formerly he was a mechanical engineer in charge of engine test, Research Division, Mack Mfg. Corp., Plainfield, N. J.

♦

Recent announcement of **Arthur E. Smith** as chief engineer of Pratt & Whitney Aircraft Division of United Aircraft Corp., East Hartford, Conn., has been made. He has been assistant chief engineer of the engine manufacturing division since 1944.

♦

Gustav Egloff, petroleum technologist and director of research for the Universal Oil Products Co., Chicago, has been elected to the presidency of the Western Society of Engineers. Dr. Egloff received the Octave Chanute Medal of the Western Society of Engineers in 1940.

♦

William H. Graves, formerly executive engineer, has been promoted to a new position of vice-president and director of engineering of Packard Motor Car Co., Detroit, Mich. **J. G. Vincent** continues as vice president in charge of engineering and member of the board of directors.

♦ ♦

American Society of Body Engineers, Inc., Detroit, recently announced the election of the following officers: **Arthur L. Bradley,** chief engineer, Wettlaufer Manufacturing Co., Detroit, president; **Carl W. Cenzer,** body development engineer, Hudson Motor Car Corp., Detroit, vice president; **Harold V. Atnip,** assistant chief body draftsman, Chrysler Corp., Detroit, secretary; **William K. Norwick,** executive assistant to director of the engineering division, Fisher Body Division, General Motors Corp., Detroit, treasurer.

♦

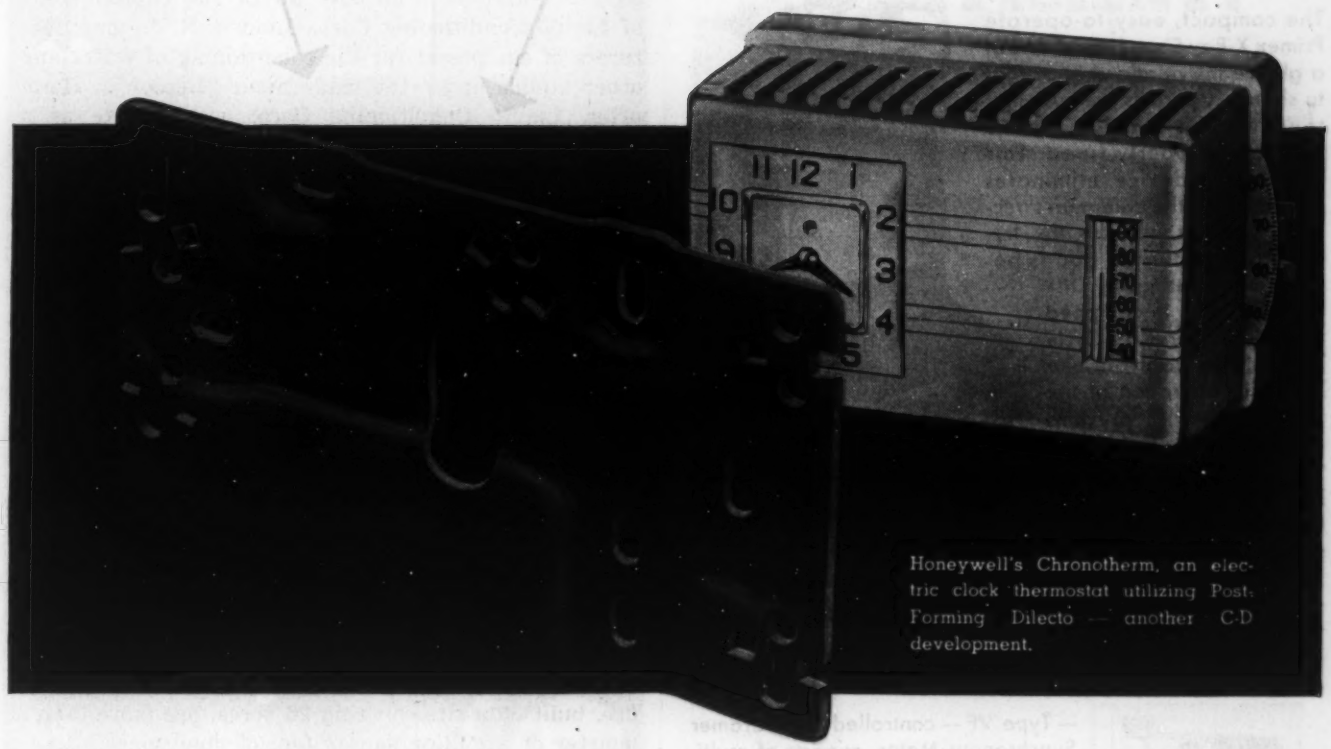
Leslie J. Woods has been appointed vice president and director of research and engineering to direct all engineering and research activities of Philco Corp., Philadelphia, Pa.

♦

Frank J. Wood has been named chief plant engineer of the fabricating division of the Permanente Metals Corp., Oakland, Calif. He was formerly manager of the Lowey Construction Co. rolling mill division of Hydropress, Inc., N. Y.

another C-D development . . .

an unusual material that can change your ideas about molding plastics!



Honeywell's Chronotherm, an electric clock thermostat utilizing Post-Forming Dilecto — another C-D development.

From Continental-Diamond laboratories comes a different plastic that makes parts production faster, easier, and more economical! Post-Forming Dilecto can be formed at a temperature of only 300°F and 200 lbs. pressure. It faithfully retains the shape you give it—eliminates the need for molding many different shapes. Expensive molding dies are no longer necessary. Available in sheet form or finished parts.

Post-Forming Dilecto is another reason why it pays to see C-D first in your search for the right plastic. For C-D Plastics provide *practical* combinations of mechanical, electrical, and chemical properties—structural strength, light weight, moisture, heat and corrosion resistance. For fast delivery or additional information, call your nearest C-D office, now.

DE-4-49

BRANCH OFFICES: NEW YORK 17, • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES. WEST COAST REPRESENTATIVE: MARWOOD LTD., SAN FRANCISCO 3 • IN CANADA: DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK 23, DELAWARE

TIME as a factor of CONTROL in Industry

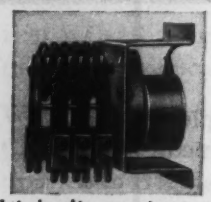
SHOES FITTED BY X-RAY

. . . Another Application of Cramer Timers

The compact, easy-to-operate Primex X-Ray Shoe Fitter shows at a glance the relationship of foot to shoe . . . permits the customer to see with his own eyes that he has been properly fitted. This convenient device eliminates doubt about the salesman's recommendations, reduces the frequency of returned goods because of misfitting.

The Primex is equipped with a Cramer CF2 Cycle Timer that controls the length of operation of the X-Ray unit . . . prevents overexposure of the customer . . . makes it impossible for the tube to be left burning, an important factor in prolonging tube life. Driven by a Cramer Synchronous Motor, the CF2 Timer performs this vital function with the same accuracy and dependability that is built into all Cramer time and control devices.

ANOTHER VERSATILE CRAMER CYCLE TIMER



— Type VF — controlled by a Cramer Synchronous Motor, consists of multi-contact open blade contacts that alternately open and close circuits in accordance with a pre-set program. It is adapted to a wide range of applications . . . hair-waving equipment, drink dispensing machines, commercial glass washing machines, etc.

A Widely Used Cramer Device
TYPE SX SYNCHRONOUS MOTOR

This compact precision-built permanent magnet type motor is a superior power plant for time control instruments requiring constant speed at a given frequency. For complete information, write for Bulletin 10B.

IF THE PERFORMANCE OF YOUR PRODUCT DEPENDS ON PRECISION TIMING, CONSULT . . .

Cramer

9CR45

News of Manufacturers

Cochrane Corp., Philadelphia, manufacturers of water conditioning equipment and steam specialties have acquired substantially all of the capital stock of **Liquid Conditioning Corp.**, Linden, N. J., manufacturers of equipment for the conditioning of water and other liquids under the trade name "Liquon". Hereafter, Liquid Conditioning Corp. will operate as a wholly owned subsidiary of Cochrane Corp., the products of the former continuing to be marketed under the Liquon trade name.

◆

L. O. Koven & Brother Inc., Jersey City, N. J., manufacturers of boilers, tanks, special process equipment and weldments, announce the addition of a metal spraying shop to its plant facilities at the Jersey City plant. Process is applicable for surfacing of shafts, spindles, bearings and bearing surfaces, tanks, patterns, cores and other assemblies and structures.

◆

Whitman & Barnes, manufacturers of twist drills, reamers, punches and special tools, have moved from their old location in Detroit, Mich., to their new plant at 40600 Plymouth Rd., Plymouth, Mich., about 20 miles west of Detroit. The modern factory and office, built on a site covering 26 acres, has more than a quarter of a million square feet of floor space.

◆

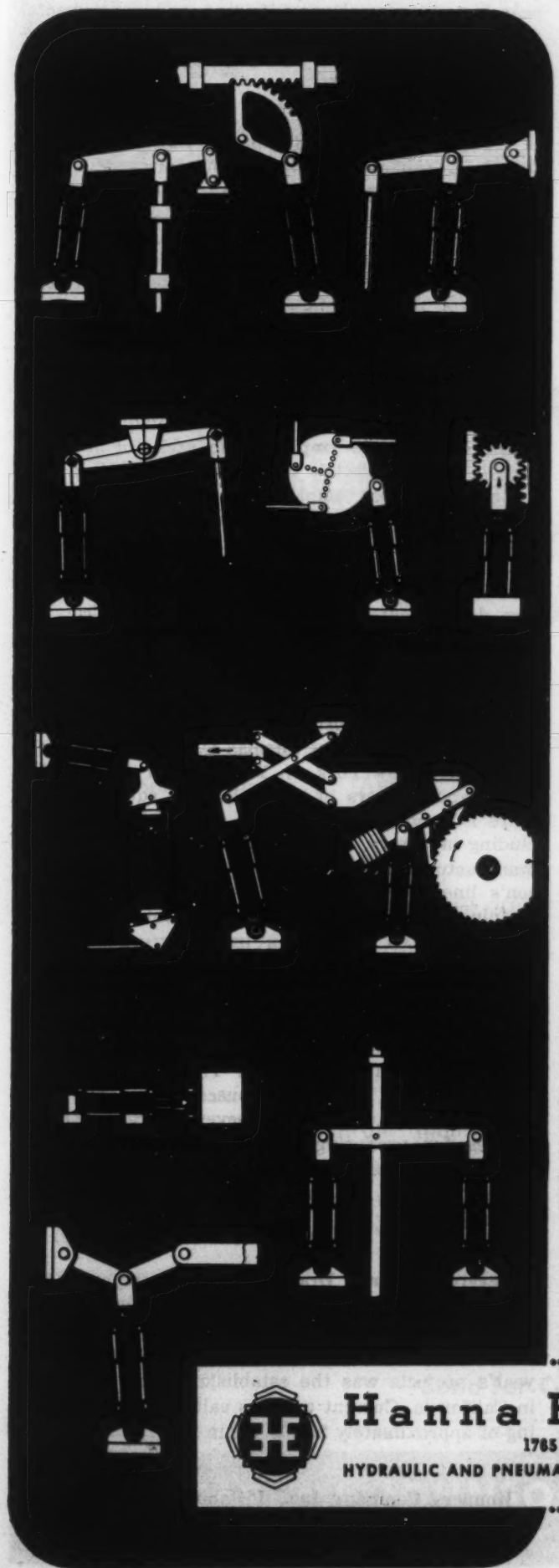
Subject to ratification by stockholders, merger of **Package Machinery Co.**, Springfield, Mass. and **Frank D. Palmer Inc.**, Chicago, Ill. has been announced. Former are manufacturers of wrapping machines while the latter are builders of general packaging machinery, specializing in continuous-motion carton-forming equipment.

◆

Clark Equipment Co. has announced the transfer of substantially all of the assets of its Celfor Tool Division, located at Buchanan, Mich., to **Avildsen Tools and Machines Inc.** of Chicago and New York. The latter is a manufacturer of tools and of machinery for making drills and other cutting tools. The acquisition of Celfor will serve to complement and round out its line of cutting tools. It will continue to market the Celfor line under the same trade name.

◆

Aiming toward closer liaison between research and experimental facilities and the production units of their organization, **General Motors Corp.** has announced that construction of a new technical center north of Detroit will begin in June. Consisting of approximately 662,000 sq ft of offices, laboratories and service units, the center will be devoted to re-



Hanna
CYLINDER POWER IS EFFICIENT!

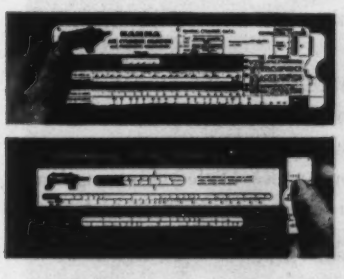
Use it 1001 ways for machine actuation and control

The fundamental mechanical movements shown here are just a few of the many ways Hanna Cylinders can work for you — to reduce costs, improve performance, get things done *efficiently*.

Thousands of Hanna Cylinders are employed throughout industry, providing smooth, dependable power in a wide variety of applications. They will push, pull, raise, lower, press, clamp or control for you. They will reduce manual efforts and speed up your production.

To find out how Hanna Cylinder Power can help you, send today for complete information.

4 "ENGINEERING AIDS" AVAILABLE...



(1) Hanna Cylinder Selector and Pneumatic Calculator . . . packed with facts and figures on pneumatic power. (2) Hanna Calculator for Hydraulic Cylinders . . . another "slide rule" which shows at a glance, information on hydraulic power and cylinder selection.

(3) Catalog 233 gives full information on Hanna Hydraulic Cylinders. (4) New Catalog 236 has 24 pages of details on Hanna Low Pressure Cylinders.

. . . Send for them

Hanna Engineering Works

1785 ELSTON AVE., CHICAGO 22, ILLINOIS

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES . . . RIVETERS

investigate...

PHENOLITE

Reg. U.S. Pat. Off

FIBERGLAS LAMINATES

Three versatile grades . . .

1. **SILCONE FIBERGLAS** — Grade G-7-830 — Combines high heat, flame and arc resistance. It is recommended for exacting low-loss electrical applications and for insulation in transformers, motors and other applications subjected to elevated temperatures.

2. **MELAMINE FIBERGLAS** — Grade MGB-811 — Extremely high tensile, flexural, compressive and impact strength values. High heat resistance and good arc resisting properties. Dielectric strength and dielectric loss characteristics excellent under high humidity conditions and elevated temperatures.

3. **PHENOLIC FIBERGLAS** — Grade GB-801 — A staple type that has high impact strength, good electrical properties and resistance to heat. Low dimensional change under moist conditions. Especially suitable for Class B insulation and other electrical applications requiring heat resistance.

For full details on Phenolite Fiberglas Laminates call or write

NATIONAL VULCANIZED FIBRE CO.
WILMINGTON DELAWARE
Offices in Principal Cities
Since 1873

search and technical fact finding and experimental development. Initial buildings in the group are expected to be ready for occupancy by early summer of 1950.

♦

Acquisition of design and patent rights on a device called Hydrabuster has led to the formation of the **Hydrabuster Corp.** in Jackson, Mich., as a subsidiary of **Aeroquip Corp.** Directors are: R. T. Hair, Service Manager of Joy Mfg. Co., Franklin, Pa.; Peter F. Hurst, president of Aeroquip Corp., Jackson, Mich.; Don T. McKone of the law firm of Bisbee, McKone, Badgley & McInally, Jackson, Mich. The new device is said to "bust" coal in coal mines without the use of dynamite or powder.

♦

Continuing to advance company techniques by providing incentive to employees to seek for improvements, **General Electric Co.** granted $277,218 in cash awards to 17,629 employees. Awards were made under the company's 43-year-old suggestion awards system which includes employees of G-E affiliated companies. Largest single award of $2,285 went to Charles Bendig, of the G-E Appliance and Merchandise departments refrigerator divisions at Erie, Pa., for an idea to improve the finishing operations on refrigerator cabinets.

♦

Tube expander business of **Richard Dudgeon Inc.** has been purchased by **Thomas C. Wilson Inc.**, Long Island City, New York, N. Y. Through the sale Wilson, manufacturers of tube cleaning equipment, acquire Dudgeon's complete tube expander business including inventory, engineering data, goodwill and sole manufacturing rights. The purchase expands Wilson's line of equipment to handle both rolling and cleaning of all types of tubing in heat transfer apparatus.

♦

Full-scale operation of Eutectic Plant No. 2 and the completion of expansion plans by midsummer are expected by **Eutectic Welding Alloys Corp.** The new plant located in Flushing, N. Y., occupies approximately 100,000 sq ft and houses a foundry, metal rolling and drawing plant, several large extrusion presses for producing coated electrodes, and alloy cutting facilities. It will also contain a complete gas welding division and special control and research laboratories.

♦

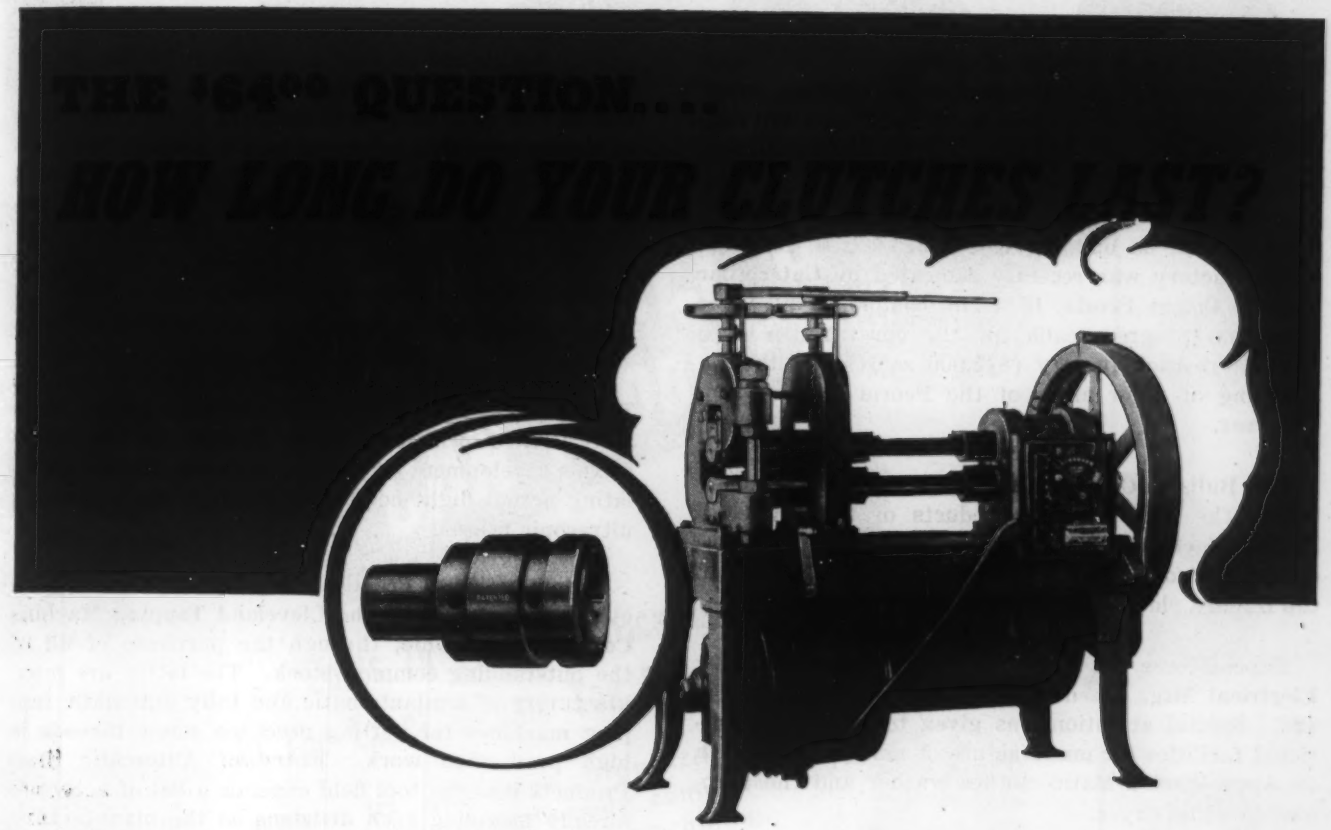
Revere Copper & Brass Inc. officers reported that $4,486,324 was expended on plant improvement and expansion in 1948, bringing total capital expenditures for the last three years to $11,252,408. Among last year's projects was the establishment of two plants in California. Current projects call for further spending of approximately $2,000,000 in 1949.

♦

Koppers Company Inc., Pittsburgh, Pa., has contracted to purchase the **Freyn Engineering Co.**, Chicago, Ill. Acquisition will include the **Open Hearth**

THE $64.00 QUESTION...

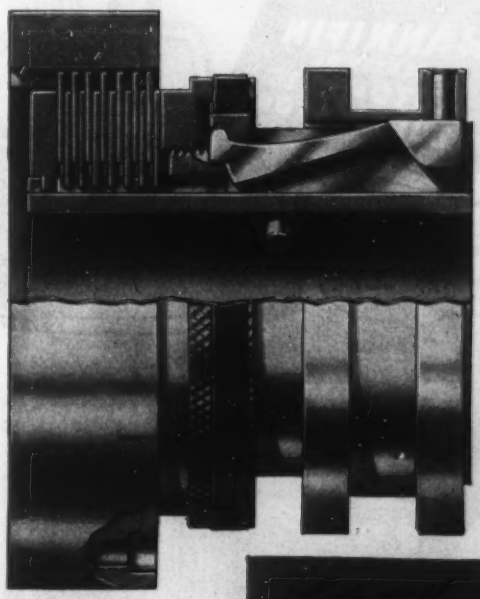
HOW LONG DO YOUR CLUTCHES LAST?



We have long known that our original clutch . . . the JOHNSON . . . was a good one but actual proof arrived the other day from Samuel Kirk & Son, Baltimore . . . "America's Oldest Silversmiths."

They asked for a few replacement parts for Johnson Clutch serial No. 64, which was original equipment in a Reverse Cross Rolling Mill, purchased from the Waterbury Farrel Foundry & Machine Co. in 1904 . . . and is still in use after 45 years of service.

The present Maxitorq Clutch . . . our compact, modernized improvement of the "Johnson"... is the result of skilled designers and careful manufacture by a company that has made clutches, only, for 46 years. We hesitate to guarantee 45 years of service, but assure you of full satisfaction when you select Maxitorq for original equipment, within its capacity . . . to 15 H.P. at 100 r.p.m. Our Engineering service is yours for the asking.



Send for Catalog No. MD7

4C149

THE CARLYLE JOHNSON MACHINE COMPANY

MANCHESTER • CONNECTICUT

Combustion Co., a subsidiary of Freyn. Specializing in design and construction of blast furnaces and open hearth furnaces, and in the engineering of mills, power stations, and other steel mill facilities, Freyn will continue under its present name as a wholly-owned subsidiary of Koppers.

♦

Designated as building KK, a 925,000 sq ft diesel engine factory was recently dedicated by **Caterpillar Tractor Co.** in Peoria, Ill. The company's post-war expansion program calls for the construction of a steel fabrication factory (875,000 sq ft) and the remodeling of older areas of the Peoria plant during this year.

♦

The Bullard Company, Bridgeport, Conn., has acquired the business and products of the **Universal Boring Machine Co.** of Hudson, Mass. Manufacture of the horizontal boring mills will be transferred to the Bullard plant.

♦

Expenditures on plant and equipment of **Apex Electrical Mfg. Co.** during 1948 amounted to $818,498. Special attention was given to providing additional facilities for manufacture of new products such as Apex Wash-a-Matic clothes washer and the automatic clothes dryer.

♦

Borg-Warner Corp. announces that $5,000,000 is expected to be spent in 1949 for the completion of their post-war $40,000,000 rehabilitation and extension program. Additional capital expenditures for the manufacture of automatic transmissions are being contemplated. To date they have acquired a $440,000 plant in Kalamazoo, Mich., for use by the corporation's Ingersoll Steel Division; a $185,000 plant at Ellwood City, Pa., for use by the Ingersoll Division for the assembly of furnaces. Erection of a $2,350,000 plant and laboratory for the Pesco Products Division at Bedford, Ohio, near Cleveland, was begun in 1948 and will be ready for occupancy by the summer of 1949.

♦

American Machine & Foundry Co. has acquired the Transducer Corp., a research and engineering company located in Boston, Mass. Transducer specializes in the development of ground training devices simulating actual flight conditions through electronic and ultrasonic means.

♦

Automatic Steel Products Inc., Canton, Ohio has acquired the control of **The Cleveland Tapping Machine Co.**, Hartville, Ohio, through the purchase of all of the outstanding common stock. The latter are manufacturers of semiautomatic and fully automatic tapping machines for cutting precision screw threads in high production work. Entry of Automatic Steel Products into the tool field expands a list of activities already including such divisions as the manufacture, assembly, and sale of mercury-actuated clutches, spun steel pulleys, abrasive grinding wheels, and automatic jacks.

Use AIR *that's* LUBRICATED!

STOPS WEAR—Here's how to make cylinders, tools, and other air operated equipment work better and last longer. Use this new Hannifin "Air Warden" Unit! Adds atomized oil to air stream. Ends worry about lubrication of inaccessible parts.

GUARDS AGAINST RUST—Leaves film of oil covering all internal surfaces to protect against rust when equipment is shut down and idle.

SAVES TIME—Works automatically. Minimizes manual maintenance requirements. Oil supply always visible through transparent bowl. Positive shut off for filling without interrupting air flow.

ECONOMICAL—Provides effective lubrication without waste. Uses oil only when air flows. Feed rate accurately controlled, visible, and fully adjustable. ⅜" and ½" sizes. *Send for information about Hannifin "Air Warden" equipment.*

The "Air Warden" Line

1. Filters Air
2. Regulates Pressure
3. Lubricates

HANNIFIN CORPORATION
1115 So. Kilbourn Ave. • Chicago 24, Illinois

EX-CELL-O
CAN PRODUCE THEM . . .
. . . Parts To Your Specifications
In The Exact Volume You Require
Within its extensive organization Ex-Cell-O has exceptionally complete and modern facilities for machining, heat treating, sub-assembly and inspection, in addition to an engineering staff widely experienced and ready to serve you in solving your parts problems. Ex-Cell-O's manufacturing skill represents the most improved methods for producing your parts—from rough stock to finished piece. Ex-Cell-O, with all these facilities under one roof and one responsible management, offers many economical advantages. To get the best in quality and economy in parts, why not send a part print to Ex-Cell-O in Detroit? Write today.
XLO
EX-CELL-O for PRECISION
To learn more about Ex-Cell-O's modern and complete parts production facilities, send for Ex-Cell-O Bulletin No. 36151.
EX-CELL-O
PRODUCTION PARTS
for New and Improved Products
EX-CELL-O CORPORATION
DETROIT 32 MICHIGAN
MANUFACTURERS OF PRECISION MACHINE TOOLS • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS
DRILL JIG BUSHINGS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT
49-28

Torque Converter Transmission

(*Concluded from Page* 120)

plied to the top of the piston. Lag of this valve is accomplished by metering of the oil displaced by the valve. Shift from high to low range is similarly delayed by the time interval of travel of the valve to the left to prevent premature engagement of the brake, particularly when accelerating to avoid an objectional torque reversal due to engagement before the engine has risen to 1.8 times its speed in high range.

Oil flows through the converter and cooling system at a calibrated rate and under pressure originating at 85 psi in the selector valve chamber, flowing through the converter inlet valve to the converter, then through the cooler and returning to the transmission case through the converter outlet valve set at 5 psi. The converter pressure is somewhat under the 85-psi pump pressure due to the pressure drop between the selector valve chamber and the converter. When the direct clutch is applied, the direct converter feed through the inlet valve is cut off and the converter is fed by leakage through various bushings of a fairly well established but a definitely smaller amount. This system permits high pressure and high flow in the converter when it is operating but low pressure and low flow when not needed, thereby facilitating direct clutch operation. When shifting into direct drive in cold weather, an additional blowoff valve is provided next to the inlet valve to reduce the converter pressure quickly and insure positive engagement of the direct clutch.

Front Pump Idles in Direct Drive

When sufficient car speed has been attained in direct drive, the rear pump moves the pump check valve forward, increasing the pressure in the pump selector valve. This results in cutting off the oil assisting the front pump relief valve spring. The pump check valve then moves forward to seal the front pump from the selector valve chamber, permitting the front pump to idle at approximately 25 psi, thereby conserving power and heat rejection.

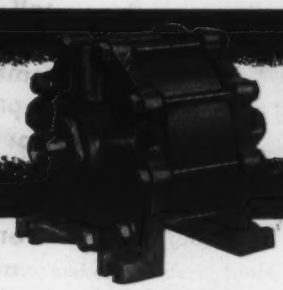
Location of the relief valve adjacent to the front pump results in reducing the idling pressure more effectively than if the valve were remote from the pump, by eliminating frictional flow resistance. When in reverse, pressure is raised to 170 psi by oil fed to the back of the selector valve on an area equal to half the normal valve area.

While cars equipped with this transmission have been driven satisfactorily over most of the road conditions existing in this country, without an oil cooler, it was felt that addition of this unit would be a safeguard against extreme or abusive operating conditions. A cooler of the multiple tube type is located in the bottom of the radiator and connected to the transmission by ⅜-inch diameter tubing with flexible connections between the tubing located on the frame and the transmission and radiator. Oil is fed to the cooler as indicated in *Fig.* 7.

* Fluid Power Improves Production

"LOGAN" AIR CYLINDERS

STANDARD AND HEAVY-DUTY MILL-TYPE



LOGAN FEATURES THAT ASSURE PEAK PERFORMANCE AND LONG LIFE . . .

- Larger ports for quicker response.
- More sturdy construction.
- Standard models available with or without cushioning.

Fast-Acting, Positive Controlled Power . . . At Low Cost

7 STANDARD MOUNTING TYPES

Standard sizes from 1½" to 12" bore; maximum stroke, 18 feet.

Special to meet your requirements.

* ENGINEERING COUNSEL

Consult our engineers. No obligation.

LOGAN STANDARD AIR CYLINDERS

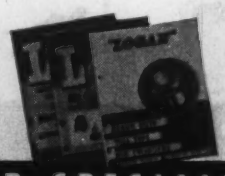
Replace most manual operations . . . eliminate human error.

Logan SAVES * TIME * EFFORT * MOTION

LOGANSPORT MACHINE CO., INC. 811 Center Ave. Logansport, Ind.

Write for FREE CATALOG

Get your free copy of catalog containing complete information on Logan air cylinders, control valves and air accessories.



LOGAN HEAVY-DUTY MILL-TYPE AIR CYLINDERS

For steel mill or aluminum extrusion mill, foundry and heavy-duty service.

FLUID POWER SPECIALISTS SINCE 1916

The Challenge of twelfth-hour changes

There's a challenge in twelfth-hour changes—a challenge that Delco Products takes pride in meeting.

Delco Products' sense of responsibility extends far beyond the mere filling of orders. Each customer is regarded as a partner on a project. His individual needs are recognized . . . his problems solved through unstinting cooperation.

All of Delco's resources are geared to the tempo of today's manufacturing. Delco has the years of experience in the appliance field needed to combine quality and quantity production. Delco has the ability to work fast. And when occasion arises, Delco has the flexibility to make schedule changes without seriously breaking stride.

DELCO MOTORS

DELCO PRODUCTS

Division of General Motors Corporation, Dayton, Ohio

Sales Offices: **CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HARTFORD**

because the element has MORE SURFACE

Additional surface for heat dissipation means higher watt ratings for Ward Leonard Ribflex Resistors, 85% to 95% higher than ordinary wire-wound resistors of same size.

Whether for continuous or intermittent duty, the high watt rating and low ohmic values make them first choice for a wide variety of heavy duty applications.

Write for Resistor Catalog. Ward Leonard Electric Co., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY

Result-Engineered Controls

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

Sales and Service Personnel

NEWLY APPOINTED sales manager of precision gear division of Foote Bros. Gear and Machine Corp., Chicago, is I. C. Maust. Mr. Maust has been sales administrator with Foote Bros., and in his new position will have charge of the sales of high precision gears, actuators and power units.

♦

J. G. Schaefer has been named manager of Allis-Chalmers' newly converted Youngstown district office, which was formerly a branch office and has been moved from the Mahoning Bank Bldg. to the Ohio Edison Bldg. Mr. Schaefer has been with Allis-Chalmers since 1935.

♦

Recently appointed vice-president in charge of engineering and sales at the Burbank division of Adel Precision Products Corp., Burbank, Calif., is Fred T. Miller, formerly general sales manager.

♦

The Elastic Stop Nut Corp. of America, Union, N. J., has appointed Charles E. Heywood service engineer. Mr. Heywood was previously associated with the Chance Vought Division of United Aircraft as standards engineer, and worked for some years with the headquarters' staff of the SAE.

♦

In order to expand its services in Detroit, the Detroit Broach Co. has appointed Henry T. Schlachter as representative to replace Earl Hovey, who is retiring. Mr. Schlachter and his associate, Bob Strange, will be located at 20201 Sherwood Ave., Detroit 12, Mich.

♦

Appointment of Howard J. Mather as assistant general manager of industrial finishes for their paint division has been announced by Pittsburgh Plate Glass Co. Mr. Mather has been sales representative for the firm for ten years in various cities and will now be located in Pittsburgh.

♦

The Johnson Rubber Co. of Middlefield, O., has appointed William R. Edwards to the position of sales manager. Mr. Edwards was associated for over twenty years with the B. F. Goodrich Co.

♦

Gilfry Ward has been appointed vice-president in charge of sales of the American Manganese Steel Division of the American Brake Shoe Co. and will be located in Chicago Heights, Ill. Mr. Ward has been associated with Brake Shoe since 1928 and spent many years with the Amsco sales organization.

♦

Additional field sales application engineers have been appointed to ten of Reliance Electric & Engineering Co's. sales offices. These men have completed a special training course in the company's engineering, manufacturing and sales departments. Their assignments are as follows: Byron O. Lutman to Detroit; Robert C. Suttle to Cincinnati; William H. Chambers to Syracuse, N. Y.; Robert L. Potter to Pittsburgh; William B. Maley to New

York; Eugene H. Sowers to Philadelphia; J. Robert Zahn to Cleveland; Robert Magnetti to Chicago; and Robert B. Reed to Birmingham, Ala. At the same time it was announced that Clyde F. Geigel has joined Reliance's Pittsburgh office as a field service engineer, and Albert M. Cherry has moved to the Rockford, Ill. sales office.

♦

The Farrel-Birmingham Co. Inc. has announced an association with C. A. Lapp, C. A. Lapp & Co., Cleveland, who will handle the sale of Farrel gears and gear units.

♦

Formerly sales engineer with Lukenweld, machinery-making division of Lukens Steel Co., Samuel Wit has been named district manager of sales of Lukens Chicago office. J. H. Fuance Jr., who has been manager of the Chicago office, will assume other duties with the company.

♦

Because of growing demand for Tinnerman Speed Nut fasteners, Tinnerman Products Inc. has moved its New York district office to new and larger quarters at 75 Roseville Ave., Newark, N. J. The new office will be under the direction of R. M. Negley, New York district manager. Also, to provide better service for customers in western Michigan and northeastern Indiana, the company has opened a new sales branch office at 212 Dewing Bldg., 132 North Burdick Ave., Kalamazoo, Mich., headed by Harry J. Greer, branch manager. Mr. Greer has represented Tinnerman in Detroit for several years.

♦

The American Brake Shoe Co. has appointed James R. Shepard western district works manager and Thomas J. Wood eastern district works manager of the Brake Shoe & Casting division. Mr. Shepard will be located in Chicago and Mr. Wood, in New York.

♦

Three appointments have been announced by the district engineering and service department of Westinghouse Electric Corp. H. E. Dralle has been named assistant manager, eastern engineering and service division; M. L. Gardner was appointed assistant engineering manager, district engineering and service department; and D. E. Inman was made assistant manager of the northwestern engineering and service division.

♦

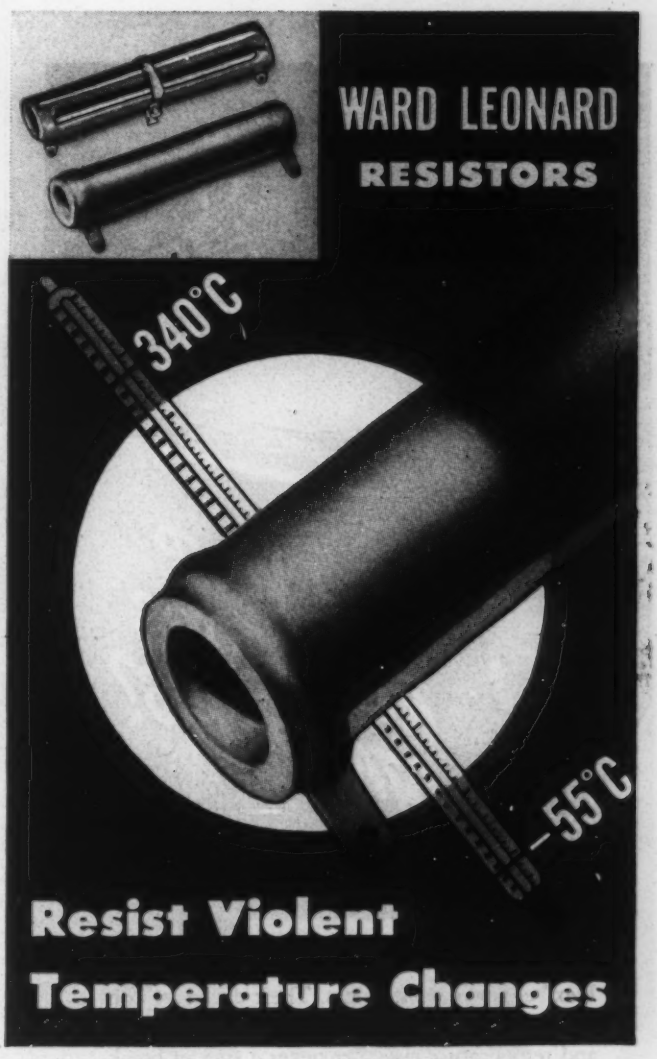
Announcement has been made by the Electric Products Co., Cleveland, of the appointment of E. Lowe McIntyre Jr. as assistant sales manager in charge of new market developments.

♦

J. T. Sudduth, a prominent manufacturers' representative in the South, has been appointed sales representative for C. A. Norgren Co. of Denver. He will handle the entire line of Norgren pneumatic products, including oil fog lubricators, air filters, pressure regulators, relief valves, air governors, needle valves, hose assemblies, and couplings. Mr. Sudduth is located at 3017 Sixth Ave. South, Birmingham, Ala.

♦

The appointment of two new assistant general managers of the General Electric Apparatus Dept. has been announced. John W. Belanger, former manager of the Turbine Divisions at Schenectady, N. Y., and Nicholas M. DuChemin, who was manager of Meter and Instrument divisions at Lynn, Mass., will also assist in directing operations of the department's product divisions, works service divisions and various works.



because all parts are

MATCHED

for thermal characteristics

Switch the temperature back and forth from 340 to −55°C, over and over, and still you won't affect the stability of Ward Leonard Vitrohm Resistors.

Reason is: Ward Leonard, making all components*, can control thermal characteristics so as to survive the greatest temperature variations.

Write for Vitrohm Resistor Catalog, Ward Leonard Electric Co., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

**Vitreous enamel coating and ceramic cores formulated and made by Ward Leonard . . . wire drawn to Ward Leonard's specifications.*

WARD LEONARD ELECTRIC COMPANY

Result-Engineered Controls

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

W L

● Not unless you have Euclid's new "Curve-Flex" edgewound resistors. Their exclusive construction flexes and stretches with current surge and temperature rise. Yet never a sign of breakage or shorting. That means you eliminate costly down-time and save replacements with E. E. resistors.

Plated metal parts resist corrosion. And their wide open construction eliminates overheating. The special alloy resistor ribbon maintains constant resistance through wide temperature change. Expansion and contraction of the frame will never damage the porcelain, thanks to Euclid's exclusive expansion joint.

Choose "Curve-Flex" resistors in capacities from 1 to 75 amperes . . . in lengths from 9 to 24 inches in three-inch increments. Both clamp and brazed type terminals are available. Ask your E. E. representative for more information or write direct to:

CURVE-FLEX RESISTORS

The Euclid Electric & Mfg. Co.
MADISON, OHIO

Greased Sleeve Bearings

(*Concluded from Page* 124)

record low pressures accurately. A better check was obtained with the early oil curves of which the 0.5L plot is shown in *Fig.* 3.

A series of tests was made at 100 and 500 rpm in addition to that at 250 rpm so as to study the effect of speed upon pressure distribution of grease. Curves from the 0.05L to the 0.5L location are plotted in *Fig.* 8[2]. The most apparent effect is a decrease in the leading-edge angle and an increase in the trailing-edge angle of the film as the speed increases. This phenomenon agrees with that found by other investigators with oil.[3] No significant changes in magnitude or position of the pressure peak were found when operating with grease. In their study of oil, S. A. and T. R. McKee[1] found that the maximum pressure increased with an increase of speed. Here it can be seen that speed has very little effect upon the pressure distribution in a grease film. The curves of integrated pressure for the three speeds are shown in *Fig.* 9.

From the results of this investigation, the following conclusions are drawn:

1. Grease can operate under hydrodynamic conditions
2. Curves of pressure distribution of the grease film are flatter and extend over a greater arc than those of a comparable oil, showing that grease has less end leakage
3. Speed affects the pressure distribution by shifting both leading and trailing edges of the grease film, but has little other effect.

The authors hope that these experiments will be of use as a basis for scientific analysis and will lead in time to a development of a theory of grease lubrication. They wish to express their appreciation to Prof. L. J. Bradford under whose supervision this work was carried out, and to The Texas Co. for facilitating this investigation.

REFERENCES

1. "Pressure Distribution in Oil Films of Journal Bearings," by S. A. and T. R. McKee, *Trans. ASME*, vol. 54, 1932, pp. 149-165.
2. Detailed test data are given in two theses presented by the authors in partial fulfillment of the requirements for the degree of Master of Science at The Pennsylvania State College.
3. "The Prediction of Bearing Performance," *Lubrication Magazine*, The Texas Company, New York, N. Y., vol. 18, December 1932, pp. 133-144.

They Say . . .

"The scientific method may be described as that method of attack which starts with a careful statement of the problem, makes a study of the background from which it arose, the previous literature on the subject, the contributions of other investigators, development of possible theories, hypotheses and processes with which to attack the problem, verification or revision of these by analysis, experiment, or both, and, finally, the development of laws, principles, or conclusions"—W. A. LEWIS, *dean, graduate school, Illinois Institute of Technology.*

Castellated Nuts Replaced—

ELASTIC STOP NUTS SAVE PRODUCTION TIME...MONEY

STERLING HEAVY-DUTY DIESEL TRUCK

The Red Elastic Collar Keeps Production Costs DOWN...*Production* UP!

On the engine rear support bolts of the Sterling Heavy-Duty Diesel Trucks, Elastic Stop Nuts have replaced castel nuts and speeded up production in a typical example of assembly line fastener simplification.

Sterling found that Elastic Stop Nuts provided the necessary positive fastening security at lower cost. Why? Because Elastic Stop Nuts lock in position anywhere on a bolt or stud—and only ONE adjustment is necessary—the first. The self-locking, self-sealing Red Elastic Collar provided the "grip-dependability" Sterling needed to keep their precise settings permanent. No amount of vibration, impact or heavy field duty can shake Elastic Stop Nuts loose.

And all Elastic Stop Nuts keep bolt and nut threads rust-free . . . seal against liquid seepage along bolt threads . . . do not damage the threads . . . and are reusable.

HERE'S A CHALLENGE: Send us complete details of your toughest bolted trouble spot. We'll supply test nuts—FREE, in experimental quantities. Write: Elastic Stop Nut Corporation of America, Union, N. J. Representatives and Agents are located in many principal cities.

ESNA

THE FAMOUS RED ELASTIC COLLAR IS VISIBLE EVIDENCE OF LOCKING SECURITY

Threadless and permanently elastic, it provides these 4 outstanding features:

1. Protects against nuts loosening due to VIBRATION
2. Keeps locking threads CORROSION FREE
3. Provides for accurate BOLT LOADING
4. Seals against LIQUID LEAKAGE along the bolt threads

ELASTIC STOP NUTS

OVER 450 TYPES AND SIZES IMMEDIATELY AVAILABLE FROM STOCK

Simplify Pneumatic Design Problems

with this unique electrically-operated

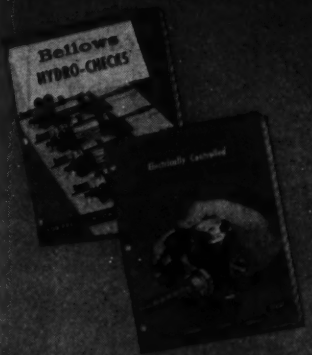
AIR CYLINDER WITH HYDRAULIC CONTROL

MODEL BSM AIR MOTOR

DC-50 HYDRO-CHECK

Permits Positive Control of Piston Speed in Either or both directions and at any point in piston travel.

Provides Absolute smoothness of piston movement — eliminates the natural "bounce" or "springiness" of air.



As a design engineer you'll be interested in knowing more about the Bellows system of pneumatic operation and controls. We'd like to send you two new bulletins showing how "Controlled-Air-Power" operates. No cost. No obligation. Just drop us a note and ask for your copies of Bulletins AV-200 and HC-600. Address The Bellows Co., Dept. MD 749, Akron 9, Ohio.

The Bellows Co.

AKRON, OHIO

Sales Notes

APPOINTMENT of two new distributors for their arc-welding electrodes has been announced by Ampco Metal Inc. of Milwaukee. These are the Omaha Welding Co., 1523 Marcy St., Omaha, Nebr., and Pye-Barker Welding Supply Co., 231 Pryor St., S. W., Atlanta 3, Ga.

♦

The Ward Leonard Electric Co. of Mount Vernon, N. Y. has appointed the Central Station Engineering Co., 2817 Groyden Dr., Tucson, Ariz., as sales representative in the state of Arizona.

♦

Two additions to the sales engineering representative organization of the Aurora Metal Co. have recently been announced. Covering southern Ohio and southeastern Indiana, James L. Erickson Sales Inc., 1811 Richard St., Dayton 3, O., is the new sales engineering representative for aluminum bronze and silicon bronze vacuum die castings. E. Metal Sales Inc., 817-819 Arcade Bldg., St. Louis 3, Mo., is sales representative for aluminum bronze and silicon bronze vacuum die castings in southern Illinois, Missouri, Kansas, southeastern Iowa and Evansville, Ind.

♦

A unique engineering computing service has been developed by a group of research engineers in Burbank, Calif. Known as the Telecomputing Corp., this organization was developed to serve engineering staffs in a wide variety of industries in computing numerical values and problems essential to converting theory and design into production. The Telecomputing Corp. is located at 2901 Hollywood Way, Burbank, Calif.

♦

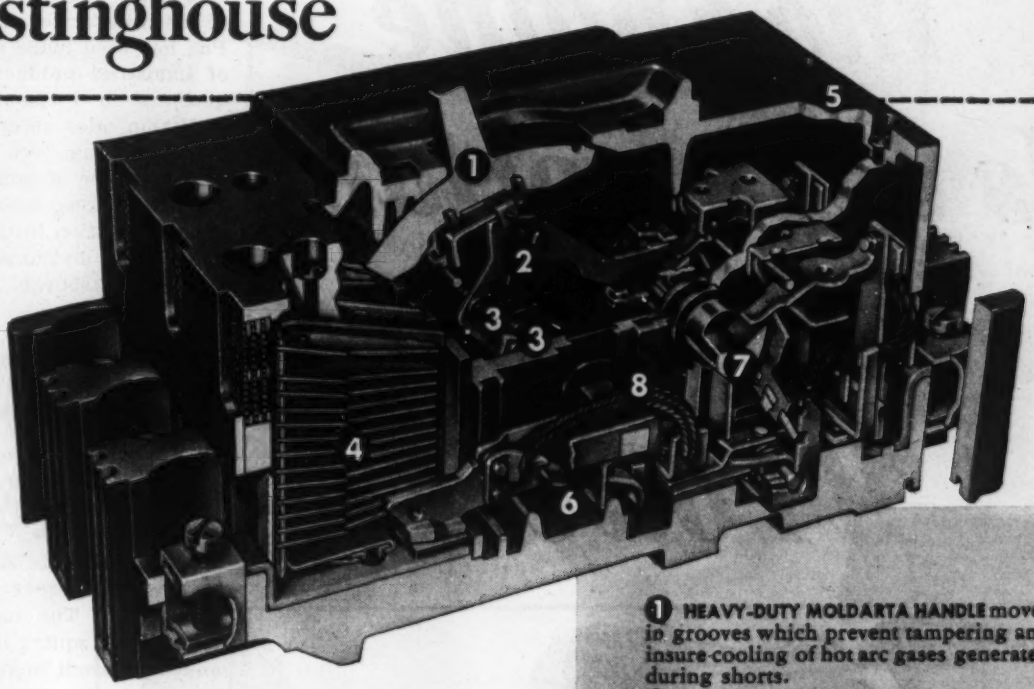
The Acro Switch Co., formerly of Cleveland, has moved to 2030 East Main St., Columbus 9, O.

♦

Four recent executive changes at Westinghouse Electric Corp. have been designed to provide for expanded post-war activities and new production lines. Vice president L. E. Osborne has been assigned staff supervision over all manufacturing activities including all matters of production and industrial relations, at the same time retaining responsibility for five major manufacturing divisions. James H. Jewell, recently

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



Count 'em...

Ten Vital Features that Save Space, Man-Hours and Dollars

You will save space, man-hours and dollars with Westinghouse Type AB Breakers—breakers that point the way to modern circuit protection by completely eliminating fuse replacement. This characteristic slashes costs and man-hours over a period of time. But that's only the beginning. Your system gets long-life, never-failing protection, too . . . the kind of protection that allows you to take the safety of your equipment for granted.

And talk about saving space—AB Breakers can be installed side by side with complete safety, operate in any position, and are completely protected against tampering.

Get complete information on today's *modern* breaker—the safe, sure, dependable AB. Call your Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-30004

1. **HEAVY-DUTY MOLDARTA HANDLE** moves in grooves which prevent tampering and insure cooling of hot arc gases generated during shorts.
2. **OPERATING TOGGLE MECHANISM** is trip-free in all positions and is the quick-make and quick-break type.
3. **ALL BEARING SURFACES** are of dissimilar metals to prevent sticking due to possible corrosion, and to prevent bearing wear.
4. **"DE-ION"** principle of arc extinction with latest improved plate structure.
5. **DEAD FRONT CONSTRUCTION** protects operator. Mechanism is entirely enclosed in hot-molded, phenolic material (Moldarta).
6. **REVOLUTIONARY CONTACT ARM** design gives increased pressure with wear; hence less watt loss.
7. **COMMON TRIP.** Multi-pole units have insulated common-trip bar that opens all poles when an overload occurs on any one.
8. **INTER-POLE BARRIERS** and insulating couplings insure protection against high surge voltages.

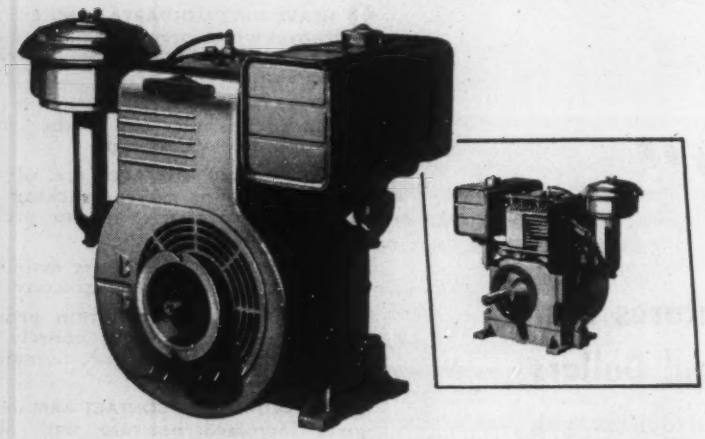
FACTORY-SEALED. Breaker is sealed to prevent unauthorized changing of calibration.

CORROSION RESISTANT. All parts are especially treated or selected to resist corrosion.

Westinghouse

AB BREAKERS

The Engine Is as Important as the Machine It Powers



It's not enough for a machine or appliance to be skillfully designed, carefully made, and expertly assembled. It has to be *powered* right, too — with the kind of power that will insure the best performance possible year after year.

That's why it will pay you to insist on Briggs & Stratton engines — recognized the world over for dependable 4-cycle, single-cylinder, air-cooled power.

No other engines in the field can assure you such efficient, dependable, low-cost performance. No other engines have satisfied so many customers. No other engines are so universally preferred by manufacturers, dealers, and users alike.

BRIGGS & STRATTON CORP., Milwaukee 1, Wis., U.S.A.

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES
Preferred Power
FOR INDUSTRIAL CONSTRUCTION RAILROAD AND FARM EQUIPMENT

elected vice president, has taken over staff supervision of all sales and marketing for the company. John K. Hodnette, vice president and head of the transformer division at Sharon, Pa., has been made general manager of industrial products, with headquarters in Pittsburgh. John M. McKibbin, also recently elected vice president, has been appointed general manager of consumer products. He will be responsible for operation and distribution in the appliance and home radio divisions and will be located in Pittsburgh.

♦

New address of the Detroit branch of the Gisholt Machine Co. is 15484 James Couzens Highway, Detroit 21, Mich.

♦

The industrial applications laboratory of the Dow Chemical Co. has been moved from Ann Arbor, Mich. to new and larger quarters in Bay City, Mich. The new location provides 10,000 square feet of floor space and will permit more effective operation and the use of larger scale equipment.

♦

Newark office of the Link-Belt Co. has been moved to larger quarters at 212 Essex Bldg., 31 Clinton St., Newark 2, N. J., and John D. Riley has been appointed district manager of this office.

♦

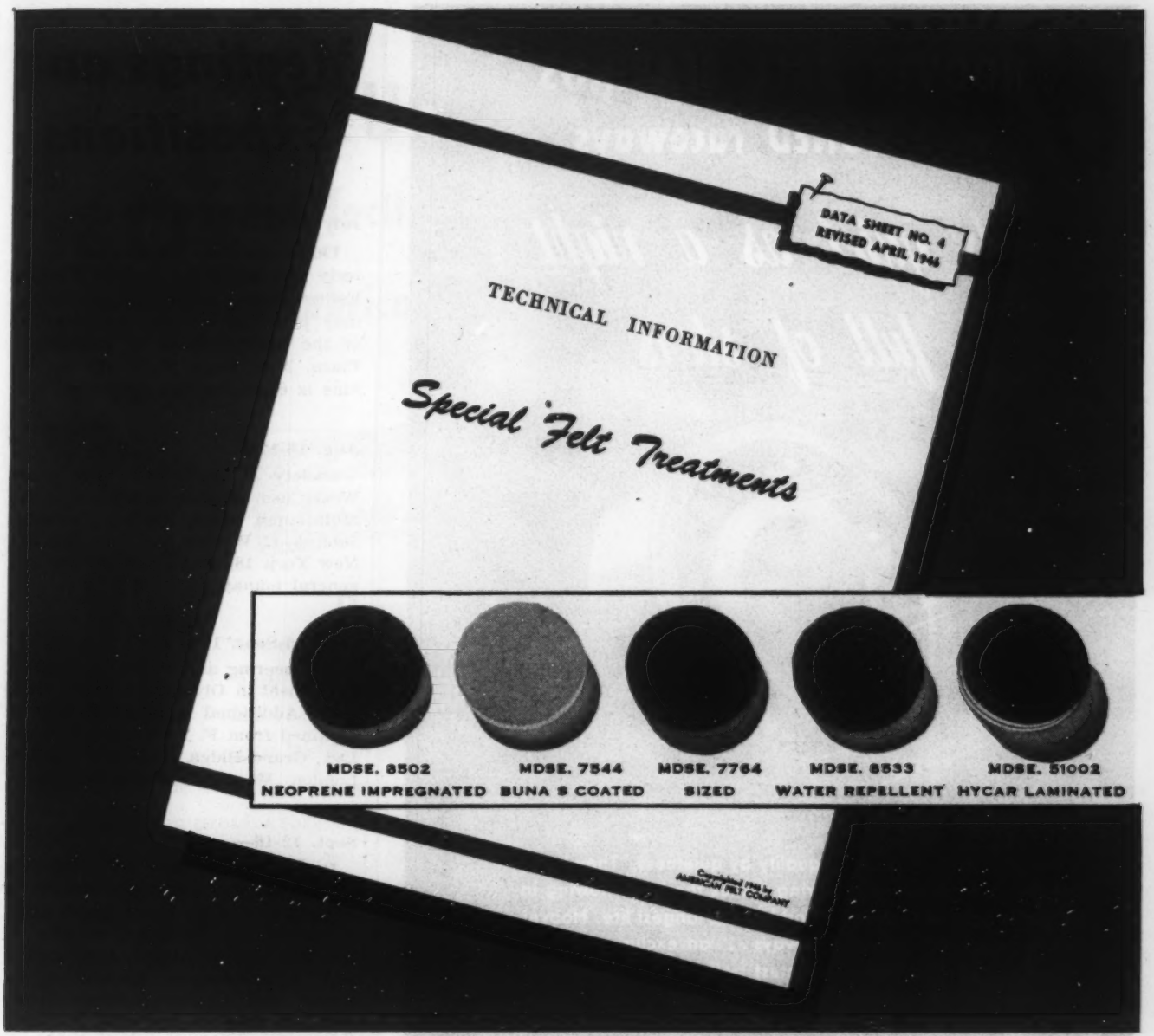
An injection custom molding division has been created at the Bolta Co., Lawrence, Mass. The Bolta Co. already produces injection molded plastic parts for the refrigeration, drug, electronic, precision instrument and electrical industries, and the formation of this new division is a direct result of the expansion of the injection molding facilities of the company.

♦

Change of address for the Boston district sales office of Cutler-Hammer Inc., Milwaukee, has been announced. Headed by C. V. Topliffe, the new office is located at 784 Commonwealth Ave., Boston 15, Mass.

♦

The Van Hala Industrial Sales Co., 1051 Power Ave., Cleveland 14, O., has been appointed exclusive sales representative for Kieley & Mueller, North Bergen, N. J. manufacturer of industrial control equipment. Also, John G. Kirkpatrick, 4405 Schenley Farms Terrace, Pittsburgh 13, Pa., has been named Kieley & Mueller representative for the area of Pennsylvania, New Jersey, and New York.



FELT HAS NO HORIZONS

SPECIAL FELT TREATMENTS MAKE FELT'S FIELD LIMITLESS

● Felt is not just felt, but an engineered material of unlimited uses. It is made in many different and closely standardized types, and in addition it can be specially treated for specific applications. For example, it can be impregnated with many substances, such as lubricants and chemicals. It can be coated or laminated with foil, rubber and plastics. Proofing can be incorporated against flame, fungi, mildew, moth, vermin, water. Sizing and resins can impart extra stiffness. Adhesive coatings can be applied that are heat, solvent or pressure sensitive. Thus felt can be said to have *no limiting horizons*. For illustrative samples and technical information send for American Felt Company Data Sheet No. 4, "Special Felt Treatments". And when ordering felt, be sure it is American Felt.

American Felt Company

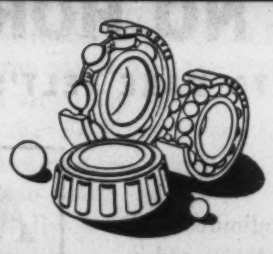
TRADE MARK

GENERAL OFFICES:
22 Glenville Road, GLENVILLE, CONN.
Engineering and Research Laboratories: Glenville, Conn.
PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I. SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

HOOVER BALL BEARINGS
with HONED raceways

As quiet as a night full of stars

In bearings engineers judge quality by quietness. They know that the quietest running bearing makes the best showing in the battle against friction . . . and has the longest life. Hoover Ball Bearings with honed raceways . . . an exclusive Hoover feature . . . are the world's quietest ball bearings. This fact has been proved by sound testing on a special radio device. In comparison with four other leading makes, Hoover won hands down! The secret of Hoover leadership in quietness is the Hoover honed raceway. Mechanically honed on special machines, Hoover makes available, at reasonable cost, a ball bearing perfection previously found only in hand-honed laboratory samples. Write, on your letterhead, for a copy of the Hoover Engineering Manual.



The Aristocrat of Bearings

Hoover Ball and Bearing Co.,
Ann Arbor, Michigan

HOOVER
AMERICA'S ONLY BALL-BEARING
WITH HONED RACEWAYS

Meetings and Expositions

July 14-15—

The Magnesium Association. Quarterly meeting to be held at Niagara Falls, Canada. Additional information may be obtained from headquarters of the association at 30 Rockefeller Plaza, New York, N. Y. T. W. Atkins is executive vice president.

Aug. 15-17—

Society of Automotive Engineers. West Coast meeting to be held at the Multnomah Hotel, Portland, Oregon. John A. C. Warner, 20 West 39th St., New York 18, N. Y., is secretary and general manager.

Aug. 25-Sept. 10—

Engineering and Marine Exhibition to be held in Olympia, London, England. Additional information may be obtained from F. W. Bridges & Sons, Ltd., Grand Bldgs., Trafalgar Square, London, W. C. 2, England.

Sept. 12-16—

Instrument Society of America. Fourth national instrument exhibit to be held in the St. Louis Auditorium, St. Louis, Mo. Technical sessions of the IIR Div. of ASME, Instruments and Measurements Committee of AIEE, IRE, AICE, American Institute of Physics and the National Telemetering Forum will also be held in the Auditorium. Richard Remback, 1117 Wolfendale St., Pittsburgh 12, Pa., is executive secretary.

Sept. 13-15—

Society of Automotive Engineers. Tractor division meeting to be held at the Schroeder Hotel, Milwaukee, Wis. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Sept. 26-28—

National Electronics Conference to be held at the Edgewater Beach Hotel, Chicago, Ill., under the sponsorship of the Illinois Institute of Technology, University of Illinois, Northwestern University, AIEE, and IRE. J. W. Armsey, Illinois Institute of Technology, Technology Center, Chicago 16, Ill., is publicity chairman.

OSTUCO ANNOUNCES

expanded facilities for manufacturing, shaping and fabricating electric welded tubing

Prompt Shipments

OSTUCO now offers you expanded facilities for *manufacturing, shaping* and *fabricating* Electric Resistance Welded Steel Tubing—facilities for cutting your production costs and insuring prompt tube shipments that will enable you to operate with lower inventories.

Produced in Carbon Mechanical Grades and in a broad range of sizes and shapes, OSTUCO Electric Welded Tubing provides many advantages for the product designer. It is highly uniform in diameter, concentricity, and wall thickness . . . easy and economical to form and machine . . . as strong at the weld as any point in the wall . . . free from seams and laps . . . smooth and clean of surface . . . low in cost.

Our fast modern machines and our many years of experience in the field of Electric Welded Tubing save you money on bending, slotting, swaging, flanging, upsetting—in fact, all types of fabricating operations. We also are in a position to supply the tubes painted or plated.

From simple round tubes to complex assemblies involving many forming and fabricating operations, OSTUCO gives engineering assistance and prompt job quotations without obligation. Write direct or to our nearest Sales Office for new free booklet "OSTUCO Electric Resistance Welded Steel Tubing."

OSTUCO

THE OHIO SEAMLESS TUBE COMPANY

Manufacturers and Fabricators of Seamless and Electric Welded Steel Tubing

Plant and General Offices: SHELBY 5, OHIO

Sales Offices: Chicago, Civic Opera Bldg., 20 North Wacker Dr. • Cleveland, 1328 Citizens Bldg. • Dayton, 1517 E. Third Street • Detroit, 2857 E. Grand Blvd. • Houston, 633 Avenue W, Central Park • Los Angeles, Suite 300-170 So. Beverly Drive, Beverly Hills • Moline, 617 15th St. • New York, 70 East 45th St. • Philadelphia, 1413 Packard Bldg., 15th & Chestnut • St. Louis, 1230 North Main St. • Seattle, 3104 Smith Tower • Syracuse, 501 Roberts Ave. • Canadian Representative—Railway & Power Corp., Ltd.: New Glasgow, Montreal, Noranda, North Bay, Toronto, Hamilton, Windsor, Winnipeg, Edmonton, Vancouver.

Can You Use These Properties of

BERYLLIUM-COPPER?

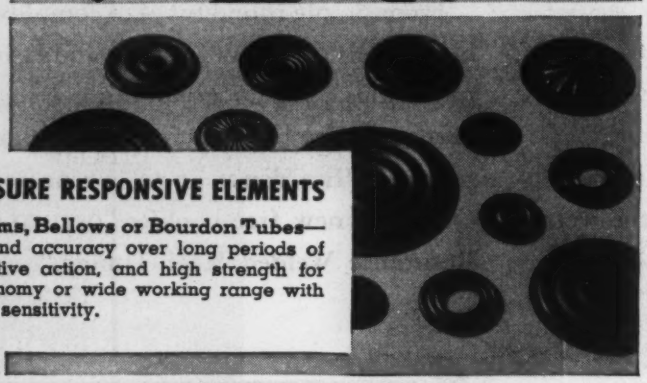
Check your design problems against these advantages of BERYLCO 25S

IN MECHANICAL SPRINGS

Compression, Extension, Flat or Torsion—high elastic and endurance strength, corrosion and wear resistance, nonmagnetic characteristics, good formability, close dimensional control and uniformity through heat-treatment, minimum drift and low hysteresis.

IN CURRENT-CARRYING SPRINGS

Connectors, Clips, Spring Contacts, or Switch Parts—the above properties plus electrical and thermal conductivity, resistance to relaxation at elevated temperatures, and the ability to maintain high and constant contact pressure.

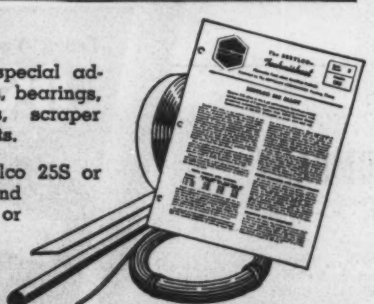


IN PRESSURE RESPONSIVE ELEMENTS

Diaphragms, Bellows or Bourdon Tubes—stability and accuracy over long periods of time, positive action, and high strength for space economy or wide working range with maximum sensitivity.

In addition, these qualities offer special advantages in the design of bushings, bearings, cams, washers, solenoid guides, scraper blades and screw machine products.

Write today for literature on Berylco 25S or if you have a design problem, send us full information with a drawing or sample of the part.



BERYLCO BERYLLIUM ALLOYS

The **BERYLLIUM CORPORATION**

Dept. 2, Reading 1, Pa.

Design Abstracts

Which Auxiliary Power System for Aircraft?

The following are abstracts of three papers presented at the recent Second International Conference of the Institute of the Aeronautical Sciences and the Royal Aeronautical Society in New York

The Case for Electrics

The power-weight ratio of electric generating units will increase as the continuous-load requirements increase. Hydraulic and pneumatic pumps driven by electric motors aid in avoiding line loss and excessive weight of pipes, in lessening the vulnerability of systems in military aircraft, and in avoiding the continuous running of pumps required for intermittent duties. In comparing electrohydraulics and electrics, there is little choice from the point of view of weight when considering large actuators. However, the electrical actuator is somewhat more efficient. Electrical actuators are easily disconnected by the removal of a plug from a socket. It is easier to design electrical systems for higher voltages and generators and motors for higher speed than it is to design and build hydraulic pumps for high speed and high pressure. The desirability of maximum electrical utilization is obvious in that all auxiliary equipment except brakes can be thus operated. Electrical equipment is easier to service, is clean, is easily controllable, and is designed to operate for long periods without attention. Aircraft designers are realizing the merits of electrical actuation, and many civil and military British aircraft will change over to electrics for many of their auxiliary services. *R. H. Woodall, chief engineer, Rotax Ltd.*

The Case For Hydraulics

If an aircraft of the Constellation type is assumed, a pneumatic system has the unacceptable features of long inflation times and the extremely high weight of bottles and the air itself, and electric actuation again introduces prohibitive weight and complication. In England, hydraulic pressure has risen more or less geometrically from 750 to 3,000-4,000 psi, whereas pneumatic pressures have been

(*Continued on page* 182)

gramix bearings help increase demand for Universal electric motors

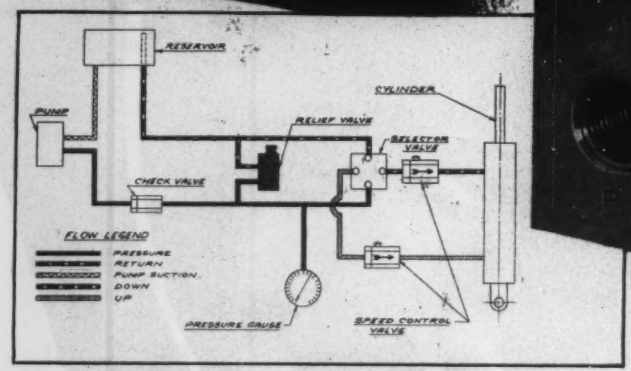
Outstanding, unfailing performance has created the *ever-increasing demand* for precision electric motors built by the Universal Electric Company of Owosso, Michigan—and that superiority is due, in part, to the Gramix bearings used in these motors. For example, the Shaded Pole Induction Type Motor illustrated, rated 1/30 H.P., is equipped with Gramix self-aligning shaft bearings. Although these bearings, like other Gramix parts, are largely *self-lubricating*, they receive additional lubrication by wicking. This assures smooth, practically frictionless shaft rotation at the rated speed of 1500 RPM. Gramix parts are *strong, tough, and economical.* Made by die pressing powdered metal to close-tolerance size, they require *no costly machining or finishing.* Bearing surfaces are perfect for rotating, oscillating and sliding motions.

We will be glad to study sketches of your products and advice you *where and how* Gramix parts may improve mechanical performance and save you money. Write today for your copy of our new 264-page catalog *of Gramix specifications and applications.*

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

NOW—
A Hydraulic Relief Valve *that Does Not Squeal or Chatter!*



Schematic drawing, at left, shows typical installation of Electrol Relief Valve being used to bypass excessive fluid pressure.

The Electrol Relief Valve Has a Dampening Device to Assure *Quiet...Efficient Performance!*

Here, at last, is a Hydraulic Relief Valve that will help you put more *quiet* into your product! It is the new Electrol Hydraulic Relief Valve—equipped with a built-in Dampening Device that smothers squeal or chatter. Designed for use in oil pressure systems, the Valve has a cracking pressure up to 90% of the full flow, with a re-seating pressure that can be held as high as 85% of the full flow.

Available in two types: The Model #523-8 measures 1⅜" x 2" x 5", has ports tapped ⅜"—18 NPT, and passes 6 GPM; the Model #523-14 measures 2⅜" x 3" x 8¼", has ¾"—14 NPT ports and passes 16 GPM. Both units have a pressure range of 100 to 2100 PSI.

Let us have a blueprint so we can work with you in adapting this Relief Valve to meet your specific requirement.

MODEL #				PRESSURE RANGE
	523-8-1		523-14-1	100-400
	523-8-2		523-14-2	200-800
(⅜" NPT)	523-8-3	(¾" NPT)	523-14-3	300-1200
	523-8-4		523-14-4	400-1600
	523-8-5		523-14-5	500-2100

Better Designed Products Use Electrol Hydraulics

Electrol
KINGSTON, NEW YORK
FOR BETTER HYDRAULIC DEVICES

developed gradually only to 1500 psi, and a sudden jump in pressure from 1500 to 3000 psi goes against the principles of good engineering.

Comparison of two theoretical elementary hydraulic and pneumatic systems leads to the conclusions that pneumatics will weigh at least the same; air-bottle weight is the main difficulty, since production spherical bottles have a weight at least twice the theoretical; the weight of air is greater than generally realized; and, with a low expansion ratio, what is gained in bottle volume will be lost in extra weight in cylinders and piping. Pneumatics are inferior to hydraulic systems in lubrication efficiency, corrosion resistance, low-temperature performance, the ability to provide locking of cylinders, the tracing of leaks, the damping of rapid motion in landing gear and other components, flow control and division, operation of motors, explosion risks, and off-loading to remove pressure from the system during long operational flights. Electric equipment suffers by comparison with hydraulic equipment in weight, emergency actuation, and some minor points. *H. G. Conway, technical director, British Messier, Ltd.*

The Case for Pneumatics

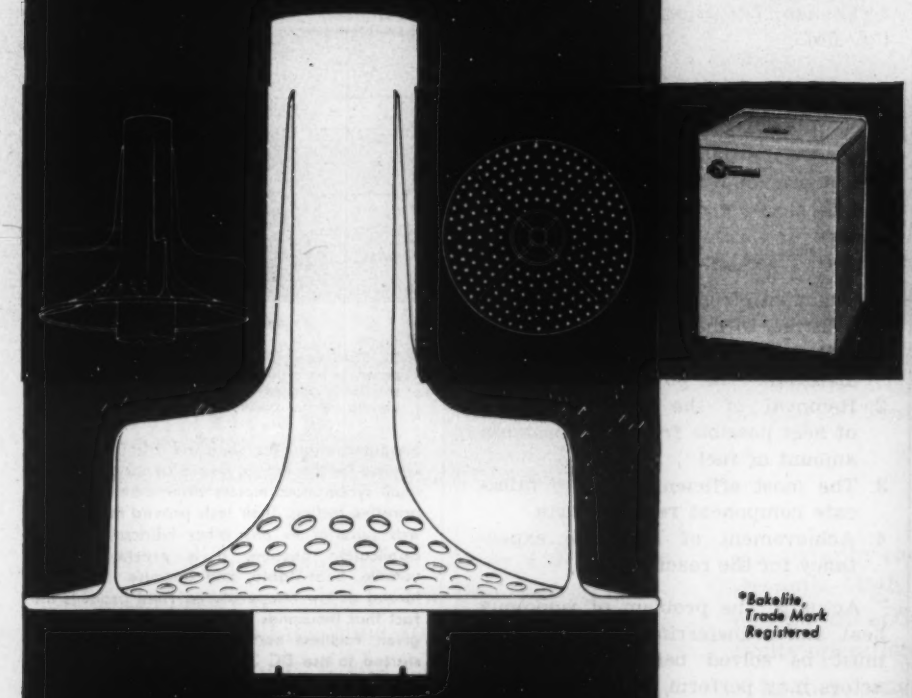
Some of the advantages of compressed air are the universal availability of air; the adaptability of compressed air to a wide range of services; and its safety, since there is no inflammable fluid and, even where methanol injection has been employed to prevent freezing of moisture in the system, no cases of fire following leakage are known. Other merits are: Greater possibilities for lightweight, reliable energy storage; fewer, simpler, and less damageable parts; lighter working fluid, pipes, rams, and storage bottles; suitability for rotary and linear motions or for inflation purposes; rapidity of operation; and cleanliness. Compressed-air systems have limitations caused by compressibility of air, low overall efficiency, leak sensitivity, and freezing in medium-pressure systems. Compressibility effects can be satisfactorily minimized by providing simple damping devices and by utilizing the damping effect of piston sealing rings, as in a typical multiposition wing-flap ram. Furthermore, pressure surges are considerably smaller than in hydraulic systems.

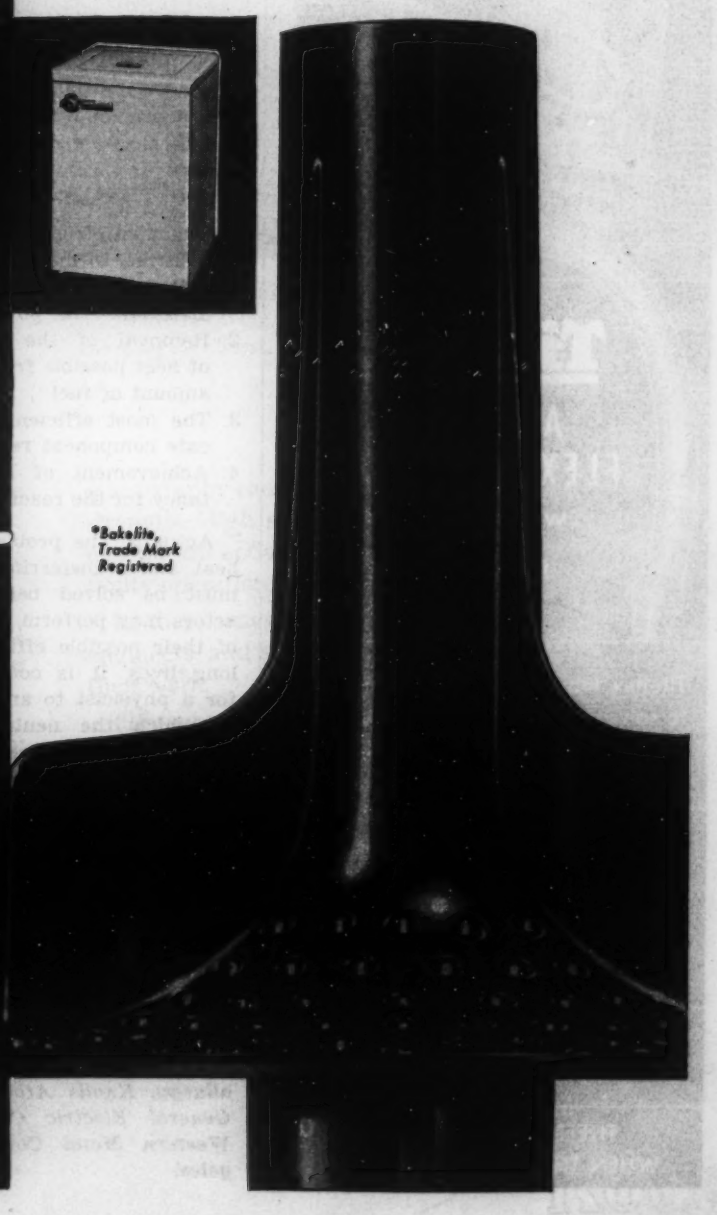
Although the inefficiency of pneumatic systems for transmitting continuous power is more marked with increase in pressure, the difficulty may be avoided by using high pressures for intermittent output and low pressures for continuous output.

one of the most unusual plastic pieces

The design called for an agitator with essentially two shafts—one carrying vanes, the other extending below the bottom of the bell. The bell itself required 192 drain holes. The entire agitator was to be driven by a spline shaft requiring a molded tolerance of .0025" plus or minus. And all this had to be done on a piece with a 14" depth of draw!

General American built a mold with a solid steel cavity. Using careful mold design and unique methods of venting, General American solved the difficult flow problems. Now the Bendix Economat Bakelite* Agitator is being made in a 4-cavity mold on a 2000-ton compression press and in a single cavity mold on a smaller press.





*Bakelite, Trade Mark Registered

Like leading manufacturers in other industries, Bendix relies on General American's 50 years' of precision production experience and on General American's equipment which includes 2 oz. to 48 oz. injection presses and compression presses up to 2000 tons (71" x 74" platen areas).

General American Plastics can serve you, too — efficiently and economically. Write to General American for information.

GENERAL AMERICAN

PLASTICS DIVISION

HOT?

Steam lines on machinery

COLD?

Coolant lines on boring mill

Titeflex

ALL-METAL FLEXIBLE TUBING withstands heat to 2100 F.

Titeflex tubing is made in 5 metals, to solve any problems of heat, cold or corrosion in handling gases or liquids. It *lasts longer* because it's all-metal . . . does not depend on packed sliding joints for flexibility. The Titeflex catalog gives full details, and our engineers are ready to assist you, without obligation. Write us.

TITEFLEX, INC.

500 Frelinghuysen Ave., Newark 5, N. J.

TITEFLEX STAYS TIGHT WHEN THE GOING IS TOUGH

Leaks in the system have usually had no serious consequences. Freezing troubles have been eliminated in medium-pressure systems by injecting methanol vapor and in high-pressure systems by removing about 99.5 per cent of the condensed water vapor in a simple, mechanical manner before the compressed air enters the system. Pneumatics are well suited for emergency services, since they are easily put into operation, are simple and light, and have shown complete reliability. Compressed-air equipment can be integrated with other systems, such as electric compressor drives, electrical synchronizing devices, and hydraulic shock absorbers or dampers. In installation, considerable latitude is permissible in the disposition of components. In servicing, they can be maintained easily by semiskilled labor, are accessible, and are comparatively immune from injury due to mishandling. *H. R. Haerle, chief technician, The Hymatic Engineering Co. Ltd.*

Atomic Power Problems

ECONOMY in production of nuclear power and fissionable materials has become a top problem of atomic science and resolves itself into four problems for materials engineers:

1. The most efficient utilization of the neutrons to maintain the chain reaction and to produce fissionable materials—the power plant fuel
2. Removal of the largest amount of heat possible from the minimum amount of fuel
3. The most efficient ways to fabricate component reactor parts
4. Achievement of long life expectancy for the reactor.

Actually, the problem of removing heat and transferring it into power must be solved before nuclear reactors may perform at the maximum of their possible efficiency and have long lives. It is comparatively easy for a physicist to arrange structures in which the neutron economy is taken care of properly but from which no power is removed. Many such structures have been built. It is the development of power (or heat) without destroying the machinery, which complicates the task.

For all practical purposes, the amount of energy in a reactor can be considered unlimited. Therefore, the rate at which it can be removed is a problem now confronting research men. *From an address by Dr. John P. Howe, head, division of metallurgy, Knolls Atomic Power Lab., General Electric Co., presented at Western Metal Congress, Los Angeles.*

Silicone News

DC SILICONES

DC Silicone (Life-time) Lubrication Pays Dividends

The more progressive manufacturers of electrical equipment have found that DC Silicone (life-time) lubrication gives their customers long term, trouble-free service. That's true in motors ranging from industrial units to the "flea-power" synchronous motors used in the kilowatt demand meters and time switches made for electric utility companies by Sangamo. These devices must give several years of continuous and absolutely accurate service whether they're installed in the North where temperatures drop to −40°F. or in the South where internal temperatures reach 180°F.

PHOTO COURTESY SANGAMO ELECTRIC COMPANY

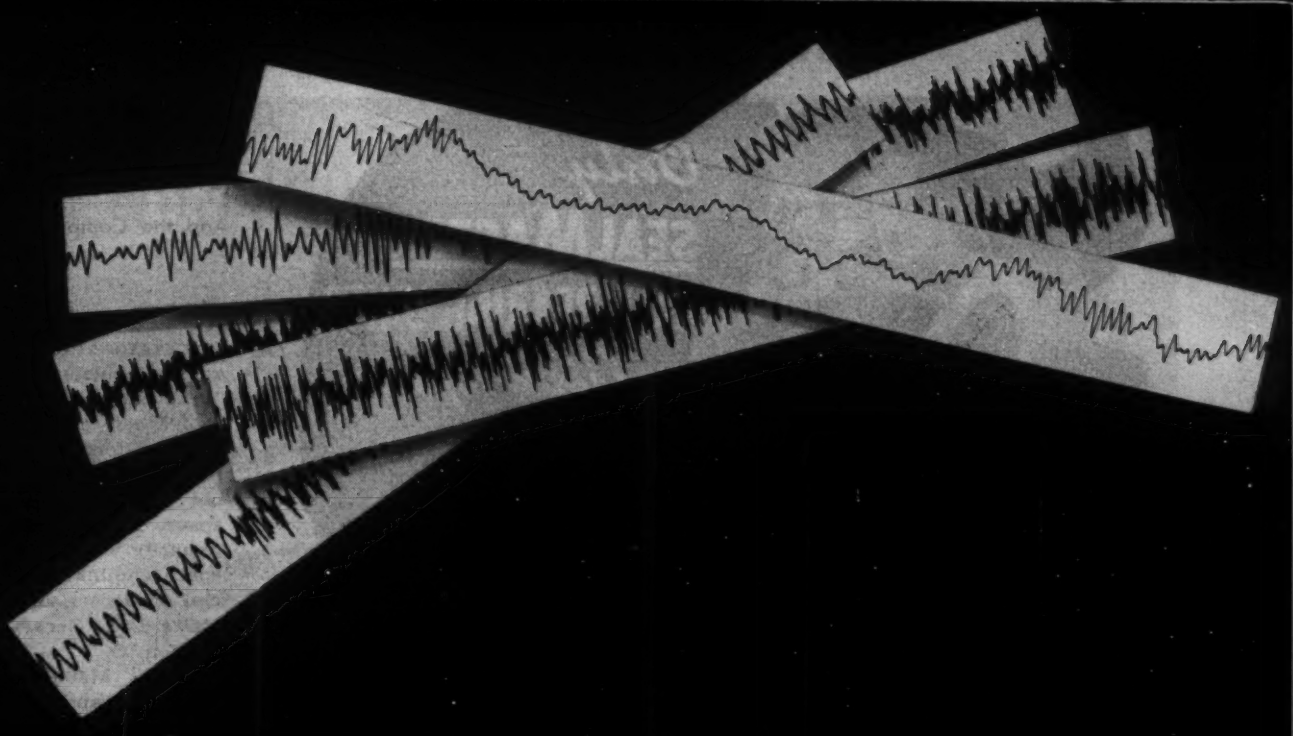
DC 33 Silicone Grease retains its consistency to permit timing motors in demand meters and time switches to operate at constant speed in spite of varying climatic conditions.

Sangamo engineers specified DC 33 Silicone Grease for the bronze sleeve bearings of these small synchronous motors after extensive comparative testing. Their tests proved that DC 33 was superior to any other lubricant for this application because it is practically non-volatile, heat-stable, and because it has low torque at low temperatures. Final proof is the fact that thousands of these little motors have given faultless service ever since Sangamo started to use DC 33 Silicone Grease over 3 years ago.

In oven and toaster timers, parking meters, wind velocity indicators and in the permanently sealed bearings of industrial motors, Dow Corning Silicone Oils and Greases have made permanent lubrication a practical reality. You can obtain more information about Dow Corning Silicone Greases from our nearest branch office or by writing for data sheet No. D5G6.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN
Atlanta • Chicago • Cleveland • Dallas
Los Angeles • New York
In Canada: Fiberglas Canada, Ltd., Toronto
In England: Albright and Wilson, Ltd., London

Dow Corning
FIRST IN SILICONES



When you talk vibration— Photography clinches arguments

Photographic records of oscillograph traces which tell how electrical appliances are behaving—foretelling how well they'll sell and work and how long they'll last.

YOU CAN put your finger right on performance peculiarity revealed by the line that an oscillograph draws—take time to study it, discuss it with others. That is, if you record it photographically. It's the way to uncover wrecking vibration and trace its cause—to drive toward a finer, more salable product.

This is one of today's important uses of photography in industry. It is typical of the way photography is used to improve a design or streamline a process.

And there are many more. Radiography, for example, can check internal structure for flaws. Photomicrography can show a metal's make-up—indicate its strength. High speed movies slow down the fastest mechanical action for careful study and so can reveal faulty operation too fast to see otherwise.

In these ways, and in many more, manufacturers, engineers, and scientists use photography to advance their work.

Photography can serve you well. In your plant, your laboratory, your office, there are matters both unusual and routine that photography can simplify and speed up. So it will pay you to write to Kodak for information when you come across a problem on which you think photography can help.

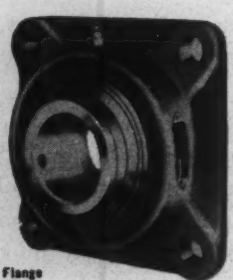
EASTMAN KODAK COMPANY
Rochester 4, N. Y.
"Kodak" is a trade-mark.

Functional Photography

ADVANCES BUSINESS AND INDUSTRIAL TECHNICS

Kodak

Important Features



Beyond the drawing board — *years from now* — the continued quiet and dependable operation of SealMaster units will amply justify their selection today. In every essential, SealMaster Ball Bearings contribute to smoother performance and low-cost maintenance. The five *important features* tell why:

1. **Permanently Sealed** — Dirt is excluded by the centrifugal flinger seals which also retain lubricant and prolong bearing life.
2. **Self-Aligning** — Shaft misalignment cannot distort the seals. Bearing unit, including seals, is independent of the housing.
3. **Pre-Lubricated** — Pre-lubricated at the factory, all SealMasters come ready for immediate use.
4. **No Housing Wear** — Patented locking pin prevents rotation of outer race in housing and positions bearing for re-lubrication.
5. **Quiet Operation** — Accomplished only by the SealMaster combination of deep-grooved, close-fitting, lapped ball races and balls and felt-lined seals.

Write for Catalog No. 845 which contains sizes, dimensions and complete engineering data.

BEARING DIVISION

STEPHEN S-ADAMSON MFG. CO.

18 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Factory Representatives and Dealers in All Principal Cities

New Machines

And the Companies Behind Them

Commercial

REFRIGERATORS. For ice cream storage. Cabinets in 3, 4, 6, 8, and 10-lid models have from 12½ to 50 per cent greater storage capacity than formerly. Four-lid model holds 25 gal ice cream, same as old 6-lid model, and requires less space. Shallow compartment customarily located over machine space eliminated by installing special condenser under cabinet. Frigidaire Div., General Motors Corp., Dayton, O.

WASHING MACHINES. Commercial models. Capacities, 60 and 90 lb. Cylinder dimensions, 30 by 36 in. and 30 by 52 in. Include larger loading door, new latches, deeper ribs. Inching device now standard equipment, safety interlock available. Simplex Div., Barlow & Seelig Mfg. Co., Algonquin, Ill.

Domestic

FREEZER. Upright, 6 cu ft model. Storage capacity, 210 lb. Requires same floor space as small refrigerator. Each of 3 compartments holds 2 cu ft. Primary refrigerating system keeps freezing compartment at 10-15 degrees below zero; secondary system keeps storage space at zero or below. One-piece, welded steel model powered by 1/6-hp unit. Westinghouse Electric Corp., Pittsburg, Pa.

Earthmoving

DITCHER. Tractor mounted, trenches to 48 in. deep, from 12 to 18 in. wide. Has 8 forward creep speeds and 2 wheel speeds to provide 16 forward digging combinations. Features wheel type construction, hydraulic lift, chain drive, and wedge type reversible and replaceable bucket teeth. Unit works within 30 in. of curbs or other obstacles. Construction Products Corp., Los Angeles, Calif.

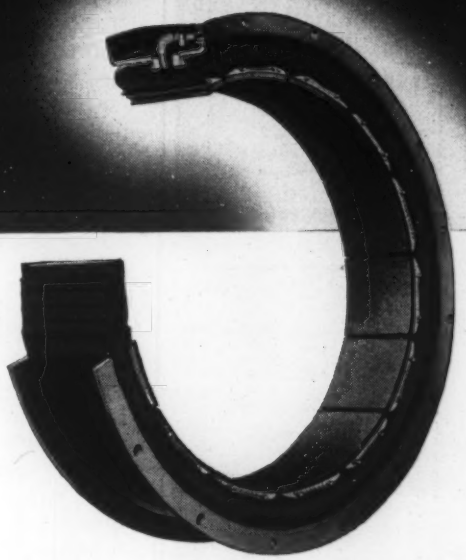
Heating and Ventilating

EVAPORATIVE AIR COOLER. For office, hotel or apartment where water connection is not practical. Capacity, 1500 cfm. Fits windows 24 to 36 in. wide. Recirculating pump and cooling system operate from 10-gal water reservoir enough for 5 hrs high-speed operation. Unit has 3 speeds, can be used as circulating fan when cooling system operation not required. Palmer Manufacturing

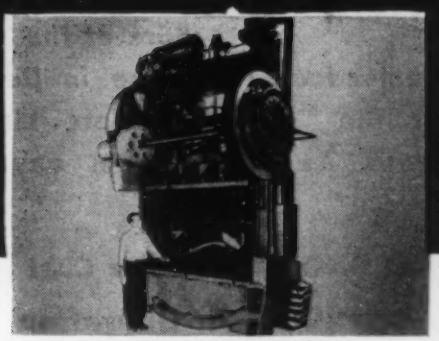
Wichita City Librar

ONLY ONE MOVING PART

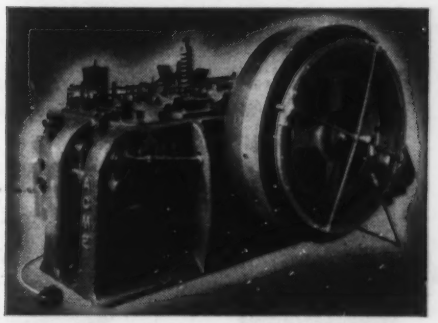
in this Fawick Clutch



Fawick Airflex Clutch or Brake Type CB



Fawick Airflex Clutch and Fawick Air-Ring Brake conversion on Model 60-D-84 Power Press.



Fawick Airflex Clutch and Fawick Air-Ring Brake on Horizontal Forging Machine by Hill Acme Company, Cleveland, Ohio.

Fawick Airflex Clutch on Brown and Sharpe No. 2A Milling Machine.

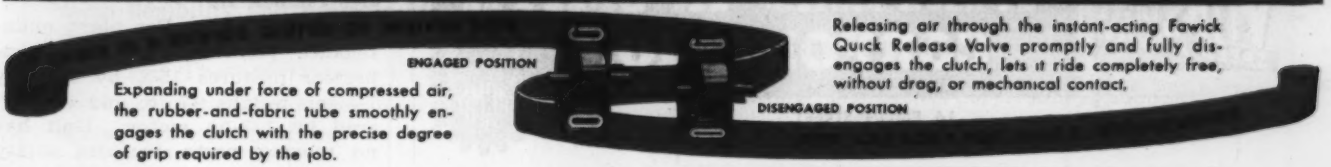
The rubber-and-fabric pneumatic tube faced with friction shoe assemblies is the only moving part in this Fawick Clutch. This part naturally stays in perfect adjustment at all times—automatically compensating for wear of the friction shoes.

Job-tested, Fawick Clutches meet the toughest operating conditions in many fields—petroleum, earth-moving, metalworking, rubber, paper, pulp and others.

Write our engineering department for a recommendation of the Fawick elements best suited for your machines. Address Dept. MD.

FAWICK Airflex CO., INC.

9919 CLINTON ROAD CLEVELAND 11, OHIO



Expanding under force of compressed air, the rubber-and-fabric tube smoothly engages the clutch with the precise degree of grip required by the job.

Releasing air through the instant-acting Fawick Quick Release Valve promptly and fully disengages the clutch, lets it ride completely free, without drag, or mechanical contact.

MOTTO for 1949

DO IT FOR LESS

Yes . . . DO IT FOR LESS with

WHS WINSMITH SPEED REDUCERS

SPEED REDUCERS

Back of the Tremendous Increase in Demand for the "Most Complete Line of Speed Reducers from any One Source" . . . . .

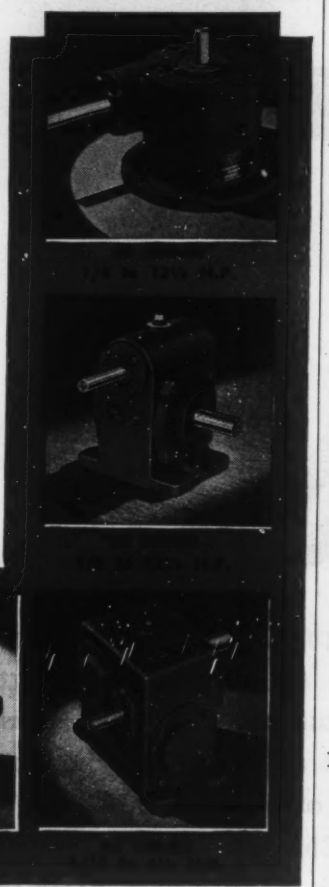
✓ **ECONOMY *in First Cost***

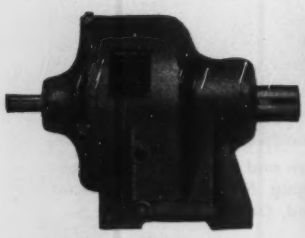
✓ **ECONOMY *in Operation***

✓ **ECONOMY *in Space-Saving***

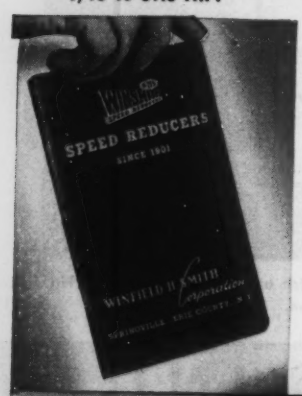
✓ **ECONOMY *in Long Life***

Let us consult with you in regard to COST-SAVING . . . no obligation





DIFFERENTIAL SPEED REDUCER
Straight Through Drive
1/10 to 81.5 H.P.



Send for Our Latest
POCKET-SIZE CATALOG

It covers our complete line . . . including the new, space-saving patented Winsmith Differential Speed Reducer. Gives ratios, horsepower, torque, overhung load capacities . . . includes valuable reference material and comprehensive Engineering Section. For Catalog 148, please write on your letterhead stating position.

See our CATALOG in SWEET'S FILE

WHS WINSMITH SPEED REDUCERS

WINFIELD H. SMITH CORPORATION

MEMBER OF AGMA

16 ELTON STREET
SPRINGVILLE . . . Erie County . . . . NEW YORK

Corp., Phoenix, Ariz.

FLOOR FAN. Cone-shaped motor housing directs cooler, floor-level air upward and outward from 4-bladed, 12-in. fan. Two-speed, rubber-mounted motor draws 85 watts at high speed. Closely spaced grill rings protect against personal injury. Robbins & Myers Inc., Springfield, O.

OUTSIDE WINDOW FAN. Belt-driven fan for mounting on outside window frame. With either hood or automatic shutter. Capacity of 24-in., ¼-hp model, 4500 cfm at 620 rpm; capacity of 30-in., ¼-hp model, 6500 cfm at 500 rpm. Chelsea Fan & Blower Co. Inc., Irvington, N. J.

AIR CIRCULATOR. In close-ceiling and suspended models, with and without luminous lighting fixtures. Fans pull up cooler, lower air and circulate it in all directions without drafts or blasts. Edwin F. Guth Co., St. Louis, Mo.

ROOM AIR CONDITIONERS. Window type units. Larger model fits windows 30 to 56 in. wide, uses 2 refrigerating units to give 1-hp capacity. Can use both units or either one depending on weather. Thermostatic control provides automatic operation of 1 unit. Cooler will condition rooms of 250 to 500 sq ft; cools, filters, dehumidifies and circulates 315 cfm of air. Smaller model, equipped with 1 refrigerating unit, fits windows 28 to 54 in. wide, delivers 200 cfm. Both models admit fresh outside air at 50 and 35 cfm. Frigidaire Div., GM Corp., Dayton, O.

Maintenance Equipment

BATTERY CHARGER. For servicing industrial electric truck batteries. Automatic in operation; current begins at proper value; current controlled throughout charge; equipment shuts down in case of power failure; charging resumes when power is restored; and charger shuts off when battery is fully charged. Made in 16 ratings to service most sizes of lead and Edison batteries. Electric Products Co., Cleveland, O.

CUTOFF SHEAR. For cutting bandsaw blades or similar materials for welding. Handles blade 0.045-in. thick and 1¼-in. wide. Cam and hand lever operated mechanism uses pivoted shear descending between 2 knife edges to give square, sharp ends. DoAll Co., Des Plaines, Ill.

PAINT SPRAY UNIT. For plant maintenance painting. Portable compressor meaures 15⅞ by 11½ by 7½-in., weighs 47 lb, and is powered by 1/3-hp motor. Unit has no moving parts, includes safety

AT A LARGE RUBBER COMPANY PLANT, American ½" and ¾" I.D. S-I Bronze Seamless Flexible Metal Hose is used for conveying steam to automobile tire tube presses. At the time the photographs were taken, these flexible assemblies had been in continuous operation for 1½ years without a leak—and, of course, are good for much more steam-tight service.

SHORT SECTIONS of 2" I.D. American Seamless Bronze Tubing, wire-braid covered for extra strength, are installed in the steam headers of a paper making machine to compensate for movement. Scene is at the Beloit Iron Works, Beloit, Wisconsin.

American Flexible Metal Tubing for Heavy Duty Steam Lines

WHERE THERE ARE MOVING PARTS . . . or vibration . . . in connection with steam lines, American Seamless Flexible Metal Connectors are in order. Seamless has the flexibility of rope . . . provides safety insurance against leaking live steam, slippery floors . . . prevents transmission of vibration from pumps and compressors. Made of bronze, with protective bronze wire braid, this tubing is exceptionally resistant to corrosion—is rugged and long-lasting.

For flexible service in a multitude of applications—conveying semi-solids, liquids, gases, etc.—there are two *basic* types of American Metal Hose products: *Seamless Tubing*, corrugated for maximum flexibility and *Flexible Metal Hose*, made from spirally wound strip with joints packed or unpacked. These two types are available in a wide choice of metals and sizes—with numerous variations in construction, braids and protective casings—and supplied complete, if you wish, with standard or special end fittings attached.

In improving the operation of old equipment, or in designing new, be *safe* with American *Flexible* Metal Hose and Tubing. Our Technical Department will help you to find the connector which best suits your needs. 49209

ANACONDA
from mine to consumer

American
METAL HOSE

THE AMERICAN BRASS COMPANY
American Metal Hose Branch
General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
Distributed in Canada by:
THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

SOLD ONLY THROUGH LEADING DISTRIBUTORS. Write the factory direct for technical information, or consult our engineers on any problem involving special sizes, shapes or materials.

ALLEN ALLEN HEAD
MANUFACTURING COMPANY
Hartford 2, Connecticut, U. S. A.
NEW YORK, CLEVELAND, DETROIT, CHICAGO, LOS ANGELES

FOR 40 YEARS THE BUY-WORD FOR SOCKET SCREWS

cut-out overload switch on motor, and is provided with cooling fins permitting continuous operation. Binks Manufacturing Co., Chicago, Ill.

STEAM CLEANER. For service stations, garages, small industrial plants, etc. Requires 27 by 37-in. floor space. Develops 80 to 120 psi working pressure, normal 45 gal per hr capacity, can be increased to 240 gal per hr by means of special gun. Features include rapid starting, automatic nozzle-control mechanism that permits operator to stop and start machine from nozzle, and selective compound and fuel feed to give best results for individual job. Units are oil-fired, electric motor driven. Homestead Valve Manufacturing Co. Inc., Coraopolis, Pa.

PROPELLER BALANCER. Averaging protractor indicates directly best angle setting of blades in hub assembly. Measures all sizes of blades. Computing mechanism automatically integrates measurements based on large number of points on blade surface. Baker Manufacturing Co., Evansville, Wis.

Manufacturing

AUTOMATIC THREAD ROLLER. For rolling machine screw sizes from #2 to #10 with Class 3 fits. Will produce 120 to 150 pieces per minute. Thread length capacity, ⅛ to 1½ in. Dies are standard flat type, held in precision-fitted die pockets by clamps. Includes automatic hopper feed with notched clearing wheel, milled and hand-scraped ways for moving die ram. Requires 4 by 5 ft floor area. Hartford Special Machinery Co., Hartford, Conn.

DIELECTRIC HEATER. For preheating large rubber and plastic preforms. Raises temperature of 10 lb average material from 70 to 250 F in 1 minute. Sliding tray handles preforms to 6 by 23 by 26 in. Occupies 37 by 37-in. floor space. Operates on 230 or 440 volts. Thermex Div., Girdler Corp., Louisville, Ky.

MULTIPLE-SPINDLE TAPPING MACHINE. For tapping automotive cylinder blocks. Capacity, 130 blocks per hour at 100 per cent efficiency. Taps 30 holes in pan rail, 14 holes in front face and 6 holes in rear face. Operator positions block in loading station, balance of cycle automatic. Cross Co., Detroit, Mich.

SURFACE GRINDER. Handles work 72 by 36 by 120 in. Two wheel heads, both of which will grind either horizontally or vertically. Designed to replace many operations formerly done on planers. Table

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

NOW...

LIFE-LINE

slashes

a-c motor upkeep costs

Here's how Life-Line motors can save you half the upkeep cost, and more.

A recent survey of 114 large motor users—operating 131,626 a-c motors of 1 to 50 hp—shows how much motors *really* cost when you figure actual "Life Cost".

The survey shows that the yearly average cost of periodically lubricated motors was $270 for every hundred motors installed.

On lubrication cost alone, Life-Line motors saved this $270. That's because Life-Line requires no periodic lubrication—no added lubrication of any kind.

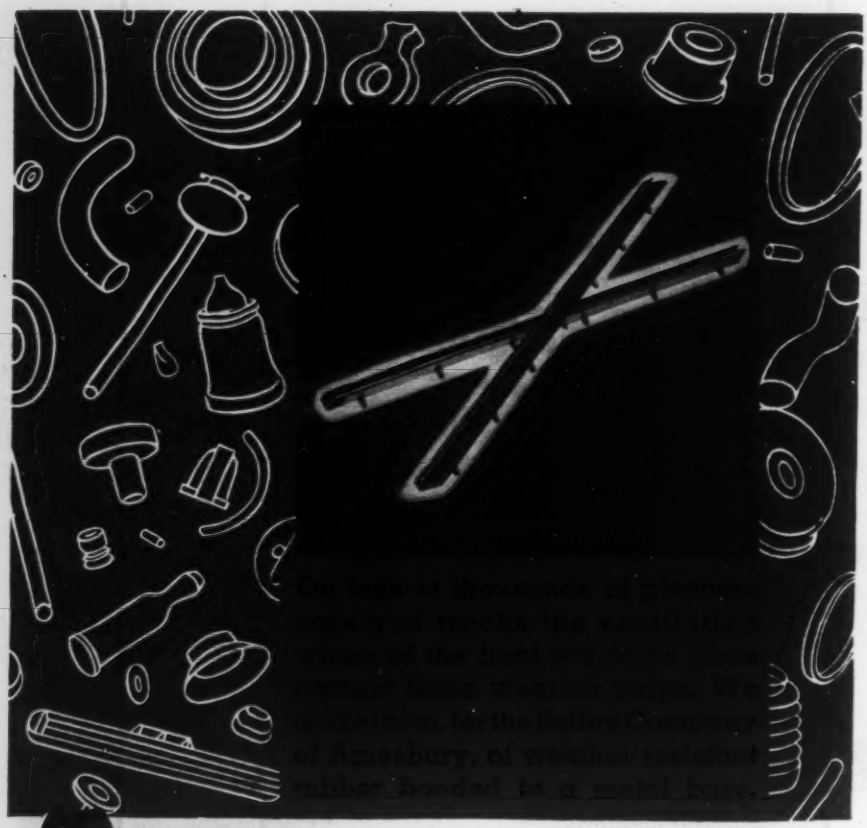
The survey also indicates that the yearly outage cost per hundred motors, for repairs and lost machine and man-hours, was $960.

The record of 500,000 Life-Line motors in service, to date, indicates a failure rate averaging less than half that of conventional motors covered by this survey. This means over 50% indicated reduction in motor outage costs—in short, a possible saving of $480 per year with Life-Line.

Add these savings—$270 for lubrication plus $480 for outages—and the result is $750 per hundred motors per year.

Can you afford to pass up savings like these? Get the facts on the savings possible in your plant. Ask your nearby Westinghouse representative for a copy of B-4321 "How to Cut Motor Costs $750". Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21514

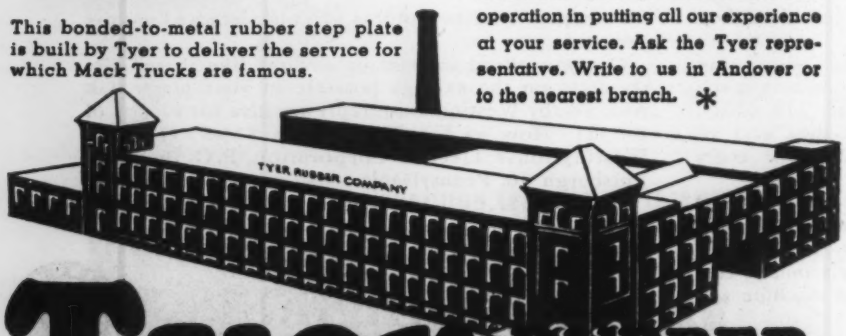
Westinghouse Life-Line Motors



Tyer has been doing things with rubber for ninety-two years and during that time has made many contributions to the art. In earlier days Tyer originated white rubber and elastic webbing. During the late war Tyer's contributions ranged from giant rubber pontons to tiny ear plugs made to a tolerance of one thousandth of an inch. Since the war Tyer has resumed its leadership in service to industry. Many of the country's finest and most famous products have at one or more vital points a rubber part made by Tyer. These manufacturers know that Tyer can do unusual things with rubber.

This bonded-to-metal rubber step plate is built by Tyer to deliver the service for which Mack Trucks are famous.

If there is a rubber part in your product (old, new, or proposed) Tyer technicians will give you the utmost cooperation in putting all our experience at your service. Ask the Tyer representative. Write to us in Andover or to the nearest branch. *



Tyer RUBBER COMPANY

* ANDOVER, MASSACHUSETTS

159 Duane St., **NEW YORK** 189 W. Madison St., **CHICAGO** 1726 Beverly Drive, **PASADENA**

speed adjustable from 10 to 100 fpm. All operating cycles automatic with provisions for hand concontrol. Thompson Grinder Co., Springfield, O.

HYDRAULIC PRESS. Capacity, 25 tons. Includes 15-in. stroke, 25-in. daylight opening, and 12-in. throat depth. Approach of ram to work variable up to 530 in. per minute. Ram stroke length, pressing speed and ram pressure can be preset. Dual hand lever, single lever, foot pedal, or pushbutton controls available or may be equipped with automatic controls for single, continuous or vibratory repeat cycling. Available with 33-in. diameter indexing table for moving parts under press ram automatically. Denison Engineering Co., Columbus, O.

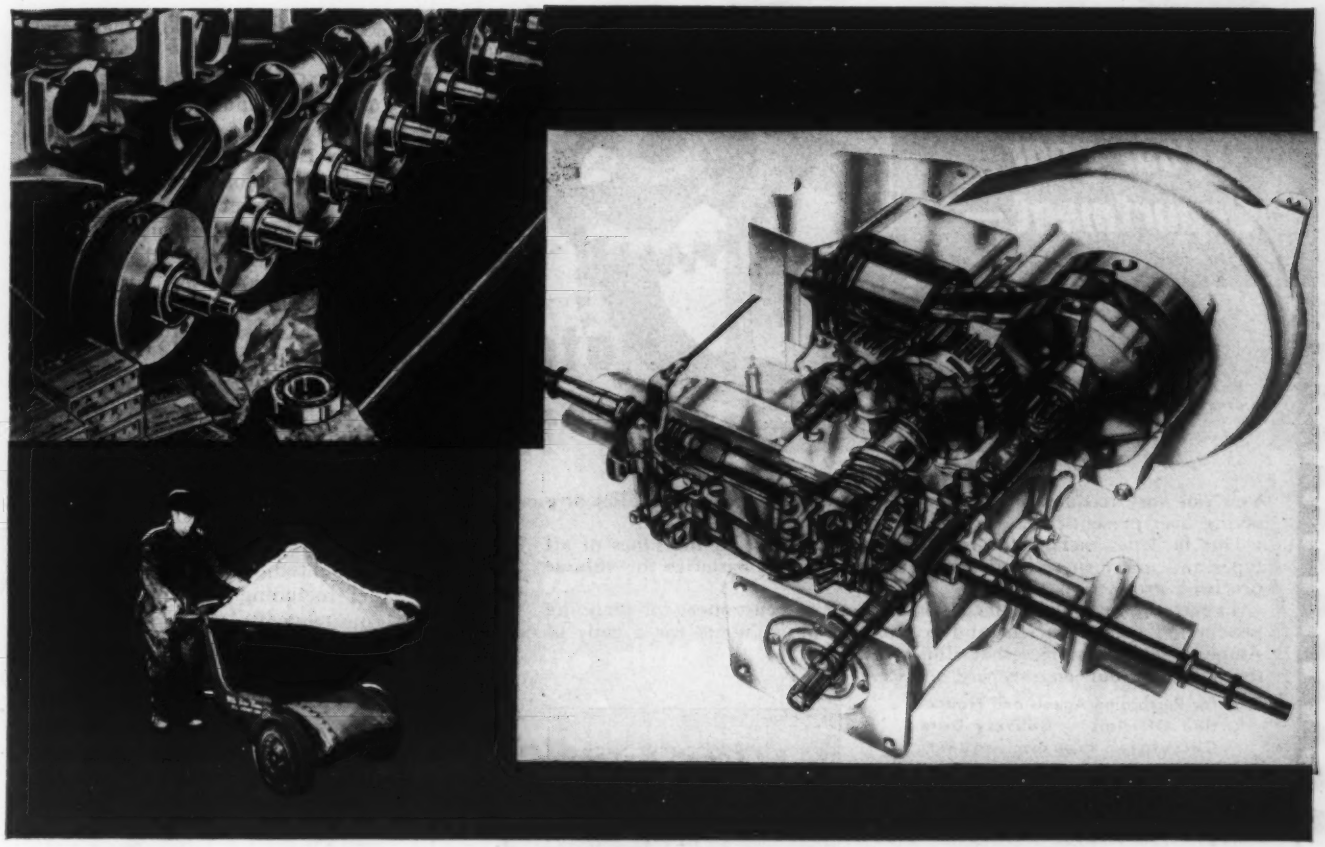
PORTABLE GRINDER-MILLER. For hand work or adaption to any lathe, milling machine of drill press. Operates mounted wheels up to 1¼-in. diameter, unmounted wheels, cut-off wheels, and metal saws with special arbors up to 2-in. diameter by ¼-in. wide and mills up to ⅜-in. diameter and 1-in. wide. Speed variable between 15,000 and 45,000 rpm. Precise Products Co., Racine, Wis.

SCROLL SHEAR. For cutting tinplate for tin can ends, or for blanking tongued bodies for rectangular, round, or tapered cans. By making scroll-cut strips, unit saves 4 to 7 per cent in stock required. Intake table has squaring device and slitter attachment which trims two sides of sheet parallel. Ball-loaded slip clutch protects mechanism in case of jamming. Shear can be equipped for hand feeding or with automatic sheet feeder. Lima-Hamilton Corp., New York, N. Y.

AUTOMATIC LATHE. For heavy duty work; includes 35½-in. swing over bedways. New hydraulically-operated #24 model includes basic features of #12 hydraulic model. Features front and rear carriages, each with own auxiliary slides; each slide with own feed pump and controls. Spindle speeds selected by pickoff gears. Starting and stopping of spindle is part of automatic cycle. Gisholt Machine Co., Madison, Wis.

Materials Handling

AUTOMATIC COAL SCALE. Dust-tight. Capacity; 10, 15 and 20 tons per hour. Scales consist of 3 major units; belt feeder, pivoted, adjustable weigh lever, and weigh hopper with bottom dump gate and closing mechanism. Operates on 110-volt a-c, guaranteed accurate within ¼ per cent of true weight.



WHEELBARROW INTO "PRIME MOVER"

Fafnir Ball Bearings help Bell Aircraft pack a lot of power into a small space

Who'd think, to look at a wheelbarrow, there was any future in it? Bell Aircraft did . . . and the result was the "Bell Prime Mover", a new materials handling machine with plenty of future. It'll take a half-ton load up a 20° grade, do the work of four men with wheelbarrows, plus snow plowing and grading.

More efficiency per pound

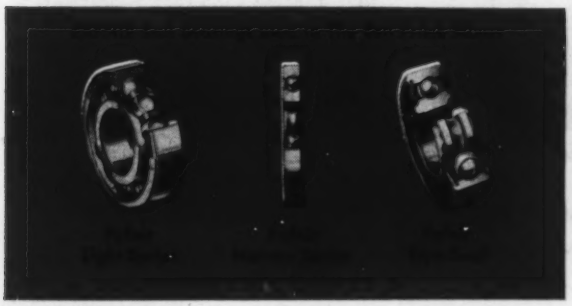
The Prime Mover gets all its power and ease of handling from an ingeniously compact 3-h.p., 2-cycle, air-cooled engine, spur gear transmission and worm gear differential tucked under the chassis between the three wheels. But space limitations are an old story to aircraft designers. And Bell's designers knew from their aircraft experience how Fafnir Ball Bearings pack extra load capacity into space-saving designs.

Name your problem . . . get a Fafnir Ball Bearing to fit it

For every spot in this new machine Bell got from Fafnir a ball bearing just right for that spot. A light series design where the load was light in proportion to the shaft capacity. A narrow series design to handle the load usually carried by a larger bearing but in a narrower width. And Plya-Seal ball bearings to give maximum exclusion of contaminants and retention of lubricant, plus removable seals for easy inspection. Each design fitted specifications as though it were "special" but all of these bearings were actually stock . . . which is one of the prime reasons for talking to Fafnir first about ball bearings.

An ATTITUDE and an APTITUDE

What Fafnir offers you is more important than any particular ball bearing. It's an attitude and an aptitude . . . a way of looking at ball bearings from where you're sitting . . . an aptitude for doing just what you'd like done about it, gained from solving the bearing problems of not just one or two industries but of all industries. The Fafnir Bearing Company, New Britain, Conn.



FAFNIR

BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

Make our plant your gear department —

Heavy pitch gears for construction equipment.

You can very frequently obtain quality gears and gear assemblies at a saving over present cost.

Our facilities include the most modern gear cutting machines of all types and many specialized machines arranged in batteries for volume precision production.

Expert engineering service is available to our customers for planning production on an efficient and economical basis. Write for a copy of Amgears Case Histories that illustrate the value of our engineering service.

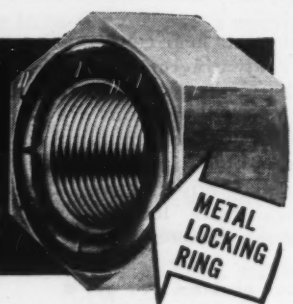
For Purchasing Agents and Production Officials — Delivery Date Calculator free on request.

*AMGEARS, INC. 6633 W. 65th St.
Chicago 38, Ill. Phone—Portsmouth 7-2100

*AM—Accurately Made

AMGEARS, INC. CHICAGO
A SUBSIDIARY OF NUPP CORPORATION
CONTRACT MANUFACTURERS
Detroit • Cleveland • Chicago

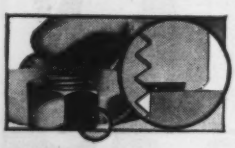
An-cor-lox gives FULL locking security



1. When nut is pulled up, metal locking ring flows into bolt threads, wedging the lock nut threads into a positive lock.
2. Once flattened by use, the non-springing locking ring stays deformed, even after backing off. Grip is increased by re-use.
3. Vibration and shock will not walk bolt off—they serve only to force the locking ring farther into the threads.
4. Bolt stretch, wear and moisture do not affect the lock.
5. Up to softening point of the metal, high temperatures do not lessen gripping power.
6. Crushed locking ring prevents passage of gas or liquids.

Available in high, thin, cap or spanner designs

Note wedging action of flattened metal ring



Send for test samples and catalog

SEE OUR CATALOG IN SWEET'S FILE

An-cor-lox Lock Nuts
TRADE MARK REGISTERED

LAMINATED SHIM CO., Inc., An-cor-lox Division, 1207 Union St., Glenbrook, Conn.

AN-COR-LOX NUTS • SHIMS • SHIM STOCK • STAMPINGS

Stock Engineering Co., Cleveland, O.

ELECTRONIC COUNTERS. Counting speed, 10,000 per minute. Operate from photoelectric or magnetic pickup sources. Designed for preset ranges of 1 to 999 gross with decade selection and direct reading count indication. Output circuits may be connected to start and stop machine operation, switch loading chutes, etc. Dimensions, 14 by 19 by 8 in. Airlectron Inc., Caldwell, N. J.

Plant Equipment

ALTERNATORS. New series with top capacity of 300 kw at 1800 rpm, 60 cycle. Available in 720, 900, 1200 and 1800 rpm models. High speed designs use direct connected exciter; lower speed designs use top mounted exciter. Complete with panel including automatic voltage regulator, voltmeter, ammeter and exciter field rheostat. Kato Engineering Co., Mankato, Minn.

INDUSTRIAL MIXER. Portable, belt-driven mixer with motor hanging on outside of tank. Interchangeable belts and pulleys make adjustments possible for mixing light, medium or heavy materials. Available with a-c or d-c standard or explosion-proof motors from 1/6 to 3 hp. United Electric Motor Co., New York, N. Y.

COOLING TOWER. Medium to large capacity; wood or steel construction. Includes nail-less filling, balanced spray system with low pressure nozzles, totally enclosed motor, cast aluminum alloy fans, hinged louver frames, and removable louvers. Marley Co. Inc., Kansas City, Kans.

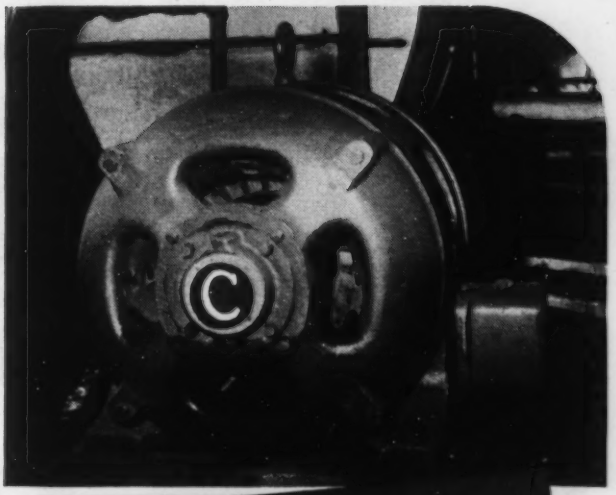
DUST COLLECTOR. Self-contained unit using portable hood for collecting dust from swing frame grinding operations. Paddle wheel fan driven by 1½-hp motor has capacity of 1400 cfm at nozzle. Cyclone separator removes larger particles; spun glass filter takes out finer dust before returning air to work space. Recirculating air instead of exhausting outside saves heat. Aget-Detroit Co., Ann Arbor, Mich.

Power Plant Equipment

TRUCK DIESELS. Three models for tractor-trailer combinations of 40,000 lb and up. Operate on 4-cycle principle, with 4⅞-in. bore, 6-in. stroke, and displacements of 457, 510 and 672 cu in. Combustion chamber design produces high turbulence, maintains low peak pressures. Variable, automatic injection timing results in good fuel economy. Mack Trucks Inc., New York, N. Y.

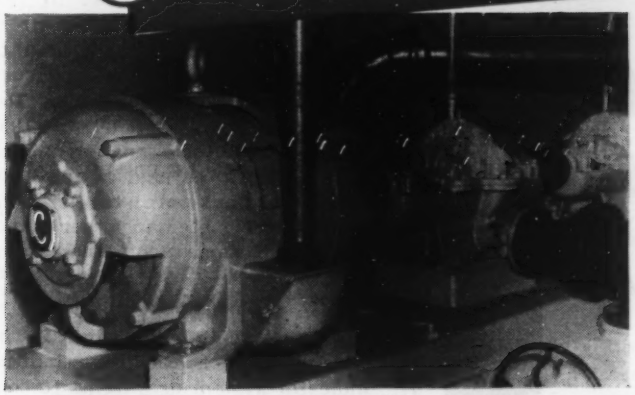
MOTOR-GENERATOR SET. For d-c power to continuous coal mining equip-

Century 40 horsepower, type SC motor driving an induced draft fan for a stack.



From Century's Line of Electric Motors You Can Select

1. **Right Kind**—*to match your current supply*
2. **Right Type**—*to meet your load characteristics*
3. **Right Protection**—*against atmospheric hazards*
4. **Right Size**—*from 1/6 to 400 horsepower*



Century 150 horsepower, type SC motor driving a two-stage centrifugal pump in a city water plant.

Two Century 75 horsepower SC high torque motors driving refrigeration compressors.

The wide range of kinds, types and sizes of Century motors makes it possible to select a standard motor to meet the requirements of all popular applications.

They are available for both AC and DC current—high, normal and low torque characteristics. Types are also available for applications requiring varying speeds and reversing direction of rotation.

To protect against atmospheric hazards, Century motors are enclosed in open rated drip proof, splashproof, totally enclosed fan cooled and explosion proof frames. Many types are available with vertical and flange mountings as well as standard horizontal bases.

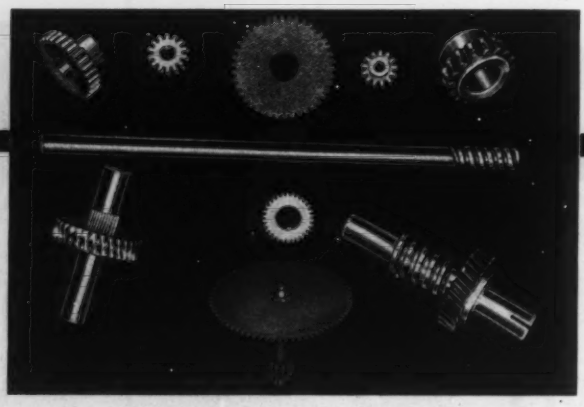
Specify Century motors for all your electric power requirements.

Popular sizes and standard ratings are generally available from factory and branch office stocks.

Century C Motors

CENTURY ELECTRIC CO.
1806 Pine Street, Saint Louis 3, Missouri
Offices and Stock Points in Principal Cities

-624



Rynel CERTIFIED Gears

FOR ALL FRACTIONAL HORSE POWER PURPOSES

OUR SPECIAL EQUIPMENT MAKES PRECISION PRODUCTION IN VOLUME A REAL ECONOMY. CONSULT OUR GEAR EXPERTS ON YOUR NEXT PROBLEM.

Rynel Corporation
STERLING, ILLINOIS

JUST PRINTED

Two bulletins showing how
NEW G-E MOTOR EXCHANGE PLAN
cuts machine down time

Get the story of the new time and money saving General Electric exchange plan for Tri-Clad integral-hp motors! It's an extension of the highly successful G-E fractional-hp motor exchange plan and covers most popular types of Tri-Clad open dripproof motors—one to five hp. Bulletin GEA-5189 is for motor users; Bulletin GEA-5180 is for machinery manufacturers. Write on your letterhead FOR FREE COPY: *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

Look for this extra on the motors you buy; it means lower maintenance costs, less time lost for motor replacement.

GENERAL ELECTRIC

756-3

ment. Portable, 300 kw set consists of 2 electrically-interconnected, skid-mounted units. Dimensions; 43 in. high, 7 ft wide, 16 ft long. Weight, 19,000 lb. Changes 2300-volt a-c to 250-volt d-c. Driven by 2300-volt, 450-hp synchronous motor; will handle 25 per cent overload for 2 hrs and 100 per cent overload for 1 minute. Compound-wound, d-c generator is of interpole design, self-excited. Reliance Electric & Manufacturing Co., Cleveland, O.

Sound Transcribing

TAPE RECORDER. Records 1 hr tape reel that can be played back immediately. Picks up any sound audible to ear. Tape erased by rerunning through recorder. Operates on 60-cycle a-c. Power output, 2 watts; recording speed of tape, 7½-in. per second; records input from phonograph or radio. Dimensions, 18½-in. long, 8 in. high, 11¾-in. wide. Weight, 29 lb. Bell Sound Systems Inc., Columbus, O.

Testing

VIBRATION PICKUP AND INTEGRATOR. For measurement of vibration displacement, velocity and acceleration in audio-frequency range. Measures displacement from 0.14-micro in. to 0.028-in.; velocity from 51.3 micro in. per second to 10.3 in. per second; acceleration from 0.15-in. per second per second to 3900 in. per second over frequency range of 25 to 3000 cycles. Response is flat from 60 to 1000 cycles. Small size enables vibration pickup to be held in one hand while readings are taken from sound level meter in other hand. Hermon Hosmer Scott Inc., Cambridge, Mass.

Woodworking

WOOD PLANER. Handles work 24 in. wide, 8 in. thick. Electromechanical indicator system uses lights to control thickness of finished work. Accuracy of 0.003-in. possible if both sides are finished. Max stock removal in 1 pass with 10-hp motor, ½-in. Cutter head is round, 4-knife, 5-in. OD type running at 4200 rpm. Feeds variable between 20 and 60 fpm forward or reverse. Four feed rolls powered by 1½-hp motor. Ballentine Industries, Absecon, N. J.

BUFFER-SANDER. For buffing, sanding, drilling, polishing and other operations in home workshop or factory operations. Diecast aluminum frame, helical spur gears included. Motor speed, 1600 rpm. Top handle and side knob for 2-handed operation molded from cellulose acetate. American Floor Surfacing Machine Co., Toledo, O.

To hang out their wash sparkling white and clean, women used to rub endlessly on a washboard, rinse again and again in a washtub. Monday's job really put them through the wringer.

Now they toss the laundry in a machine that washes, rinses, and spin-dries in a matter of moments... thanks, in many cases, to a drive mechanism which depends on R/M clutch facings.

A small application, true. But R/M friction materials are doing a *big* job for housewives and for appliance manufacturers... just as they are for makers and users of cars, trucks, and draglines. It's not the size of the part that counts; it's the experience and know-how that go into it.

Whatever your product, whatever your problems in design or supply of brake linings and clutch facings... you'll find the R/M representative a good man to know. He brings you the experience and the production capacity of four great plants, four research organizations, and four testing laboratories... all the facilities of the largest producer in the friction material industry.

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION **620 Fisher Bldg., Detroit 2, Mich.**

445 Lake Shore Drive, Chicago 11, Ill. 4651 Pacific Blvd., Los Angeles 11, Calif.

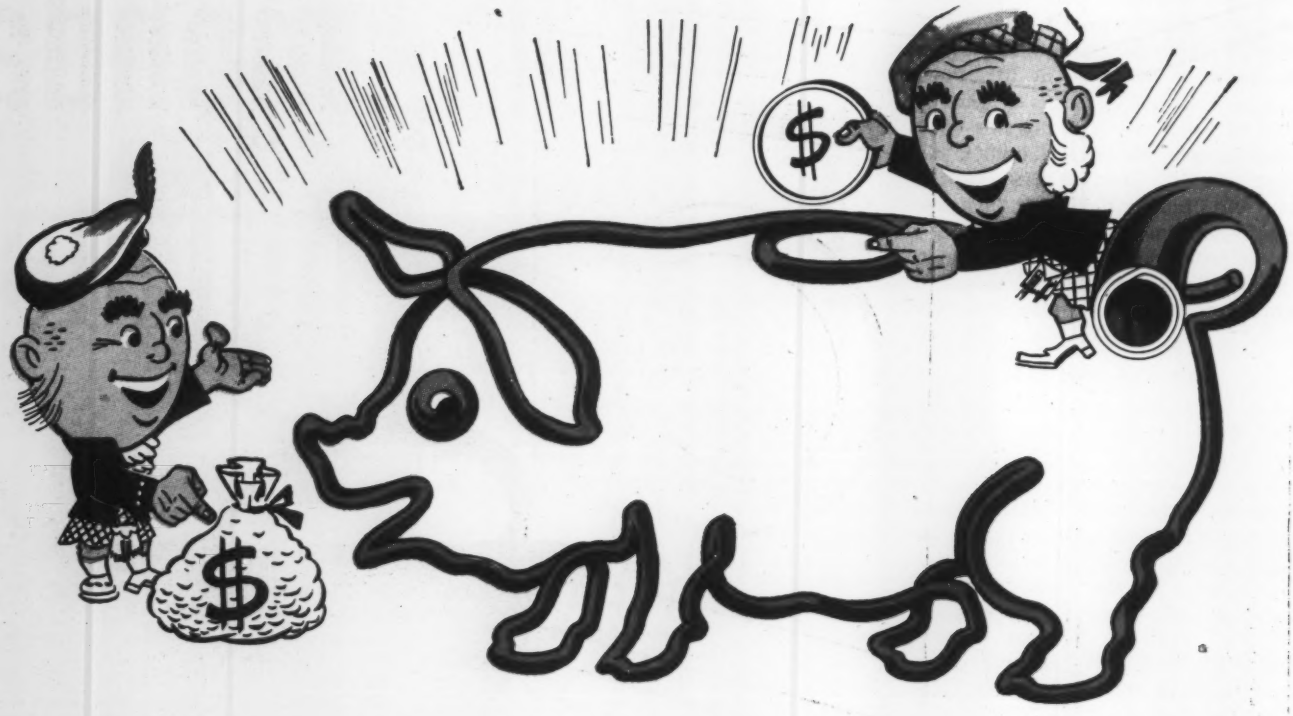
1071 Union Commerce Bldg., Cleveland 14, Ohio

Factories: Bridgeport, Conn. Manheim, Pa. Passaic, N.J. No. Charleston, S.C.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Brake Linings • Brake Blocks • Clutch Facings
Fan Belts • Radiator Hose • Mechanical Rubber Products • Rubber Covered Equipment • Packings
Asbestos Textiles • Powdered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

RM

FIRST IN FRICTION



Profit with Bundyweld for your tubing needs

You'll profit in faster production, better design, higher quality or lower cost by using Bundyweld* Steel Tubing.

And here's why!

Bundyweld is made by a patented process . . . *the only tubing that is double-walled from a single strip.* Extra-strong and sturdy, it's long-wearing, ductile and easy to fabricate. The tubing walls are bonded throughout all points of contact, making it much more resistant to vibration fatigue and more leakproof than most other types of tubing. And it's lightweight, thinner-walled, faster-cooling. With all this, you'll find that Bundyweld's cost is surprisingly low.

No other tubing on the market can match *all* the advantages Bundyweld offers. That's why you'll find it in so many diversified fields . . . fields like refrigeration, machine tool, automotive, range, television, radiant heating and tubular toys, to mention only a few.

Why not let this miracle tubing of industry improve your tubular design, structural or functional application? Contact your near-by Bundy representative among those listed below, or write direct to: *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS

*REG. U. S. PAT. OFF. ®

WHY BUNDYWELD IS BETTER TUBING

1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.

2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.

3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.

4 Bundyweld comes in standard sizes, up to 5/8" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES

Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 404 Architects Bldg. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 3628 E. Marginal Way • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 881 Bay St.

BUNDYWELD NICKEL AND MONEL TUBING IS SOLD BY DISTRIBUTORS OF NICKEL AND NICKEL ALLOYS IN PRINCIPAL CITIES.

Two Processes that can give YOUR STEEL PARTS a Longer Life

CHAPMANIZING
FOR LOW CARBON STEELS

MALCOMIZING
FOR STAINLESS STEELS

If you want longer wearing steel parts . . . fast, modern superhardening . . . investigate these two Chapman processes. Both are relatively inexpensive! Both are fast! Both mean greater wear resistance for parts or products!

CHAPMANIZING. *In only 1 to 4 hours* Chapmanizing will give free-working steels an alloy-like case from .002″ to .035″ deep. So tough and ductile is this case that it will not chip or check. It's silver-clean, too, requiring minimum finish grinding.

MALCOMIZING. *Producing an average surface hardness of 1000 Vickers,* Malcomizing gives stainless steels a case that's highly resistant to corrosion and wear. Case depth ranges from .005″ to .015″. Since maximum hardness is slightly below the surface, finish grinding or lapping is possible.

Write today for the booklet describing these two Chapman processes.

Metallurgical Sales Division of
The CHAPMAN VALVE MFG. COMPANY
INDIAN ORCHARD, MASSACHUSETTS

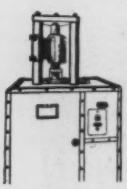
For Designers WHO WANT *COLD FACTS* ON "*HOT*" APPLICATIONS

BALDWIN HIGH TEMPERATURE TESTING EQUIPMENT . . . There's a "fourth dimension" in testing today, bounding a new field where the properties associated only with length, breadth and thickness are inadequate to forecast performance.

This new dimension is *temperature*. The progress made to date in high-pressure steam turbines, in gas turbines, in jet engines, and in oil refinery equipment, has rested on the designers' knowledge of the effect of elevated temperatures on the properties of metals. Further progress will depend on the speed with which the horizons of this knowledge are expanded.

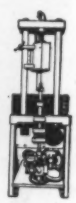
To aid explorers in this field, Baldwin has developed these interesting new items of high temperature testing equipment. Furnaces which are supplied as standard equipment are suitable for obtaining temperatures up to 1800° F. Special furnaces are available which will produce temperatures up to 2200° F.

BALDWIN LEVER TYPE CREEP MACHINE. Maximum capacity 12,000 lbs. Loading accuracy within 1% of load, and accuracy of strain measurement is within .00005-inch. Over 150 of these machines are now in use in leading laboratories.

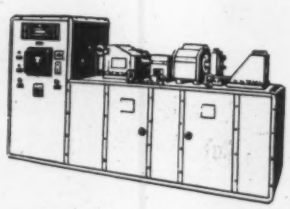


BALDWIN SONNTAG SF-4 FATIGUE MACHINE. The first "constant force" fatigue machine permitting application of furnace and control equipment for direct stress fatigue testing at elevated temperatures. Static pre-load 0 to 8,000 lbs.; dynamic load capacity ±5,000 lbs. Maximum capacity, one direction, 13,000 lbs.

BALDWIN SCREW TYPE CREEP RUPTURE MACHINE. Motor driven, capacity 20,000 lbs. Automatically maintains loads while temperature is held constant. Flat chart recorder plots elongation vs. time.



BALDWIN CONSTANT STRAIN RATE CREEP TESTING MACHINE. For determination of effect of various strain rates on the breaking points of metals, at controlled high temperatures. Head velocity can be varied from 0.6 inches to .000001-inches per second.



BALDWIN SONNTAG SF-5 FATIGUE TESTING MACHINE FOR TURBINE BLADES. Maintains a predetermined fixed load up to 8,000 lbs. while applying alternating flexure loads up to ±1400 lbs. at controlled high temperatures. Simulates service conditions.

HELPFUL TECHNICAL LITERATURE AVAILABLE. Technical bulletins, giving full details on the various equipment described above are available on request. Please indicate the machine in which you are interested, or the type of testing that you plan on doing.

The Baldwin Locomotive Works, Philadelphia 42, Pa., U. S. A. Offices: Boston, New York, Philadelphia, Houston, St. Louis, Chicago, Cleveland, Pittsburgh, San Francisco, Seattle, Washington. In Canada: Peacock Brothers, Ltd., Montreal, Quebec.

testing headquarters → **BALDWIN**

NATIONAL OIL SEAL LOGBOOK

USE OF EXTERNAL-WIPE SYNTECH OIL SEALS FOR WHEELS AND SIMILAR APPLICATIONS

External-wipe National Syntech seals are ideally suited for front wheels of cars and light trucks; and for trailers, where wheels are removed and remounted frequently.*

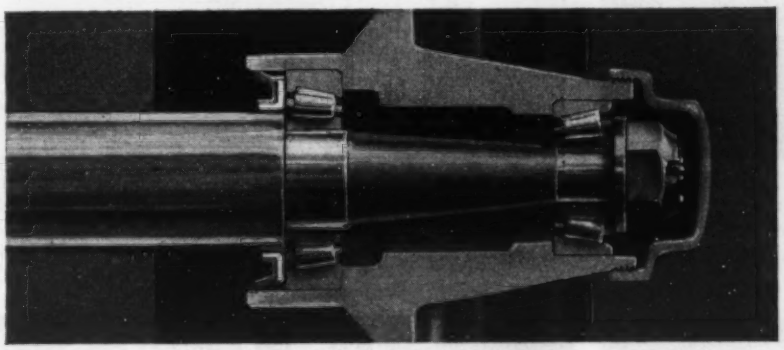


Figure 1—Typical Wheel Application

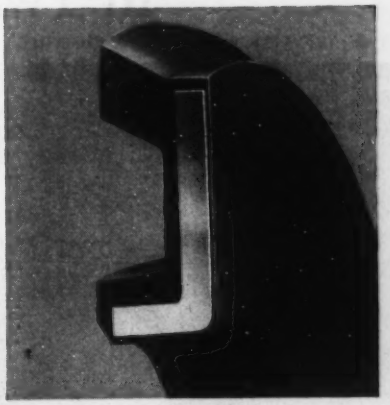


Figure 2
Springless External Wipe Oil Seal

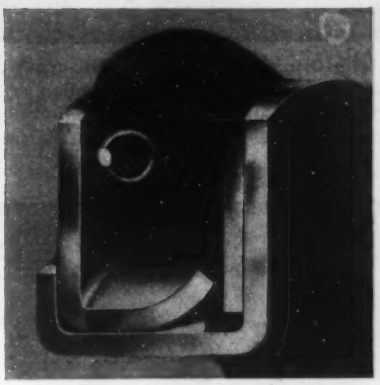


Figure 3
Spring-loaded External Wipe Oil Seal

NEW external-wipe oil seals with synthetic rubber sealing members offer important advantages to automotive manufacturers. In many wheel applications, they facilitate assembly, make wheel removing and remounting easier, give zero-leakage, low-torque sealing and moderate cost.

An exceptionally good use of National Syntech external seals is the car trailer wheel (Fig. 1). Here the manufacturer requires long-wearing, zero-leakage seals that can be left on the hub when wheels are removed. New National 360,000 Syntech externals (Fig. 2) not only meet these requirements, but actually simplify wheel shifting. This is because (a) these seals press-fit onto the hub and are thus not moved when wheels are dismounted, and (b) sealing lips point inward, so remounting is completed *with* instead of *against* the sealing direction.

For superior sealing, these National Syntechs also have rubber-covered Inside Diameters. And their simplicity of design means a substantial saving to the manufacturer—better sealing at less cost!

For other mechanisms where extreme dust, dirt, heat or speed conditions exist, other new National external Syntech seals are available. For example, in high speed, high temperature applications (such as aircraft landing wheels, etc.) where centrifugal force is a factor, a spring-loaded external Syntech (Fig. 3) proves highly effective.

For complete information on new National Syntech seals and their application to your product, consult the nearest National Oil Seal Engineer, or write direct to factory.

* *Trade Mark Registered*

NATIONAL
OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City and Los Angeles, California; Van Wert, Ohio

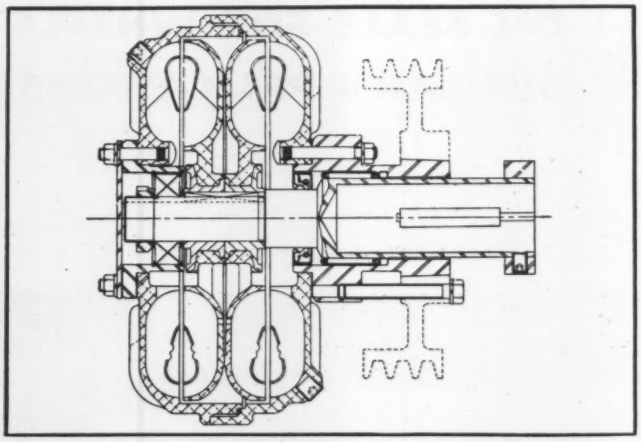
1916

CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS

BUFFALO: 56 Arlington Place, Grant 2280.
CHICAGO: Room 2014 Field Building, Central 6-8663.
CLEVELAND: 210 Heights Rockefeller Bldg., Yellowstone 2720.
DALLAS: 30½ Highland Park Village, Justin 8-8453.
DETROIT: Room 1026 Fisher Building, Trinity 1-6363.
HOUSTON: 6731 Harrisburg Boulevard, Wayside 3-1246.
LOS ANGELES: 2244 East 37th Street, Kimball 6384.
MILWAUKEE: 647 West Virginia St., Marquette 8-8986.
NEW YORK CITY: 122 East 42nd Street, Lexington 2-8260.
PHILADELPHIA: 401 North Broad Street, Bell-Walnut 2-6997.
REDWOOD CITY, CALIF.: Broadway and National, Emerson 6-3861.
WEST SPRINGFIELD, MASS.: 1025 Elm Street, Springfield 2-1881.
EAST SYRACUSE, N. Y.: 226 Roby Avenue, East Syracuse 366.
WICHITA: 340 North St. Francis Ave., Wichita 2-6971.

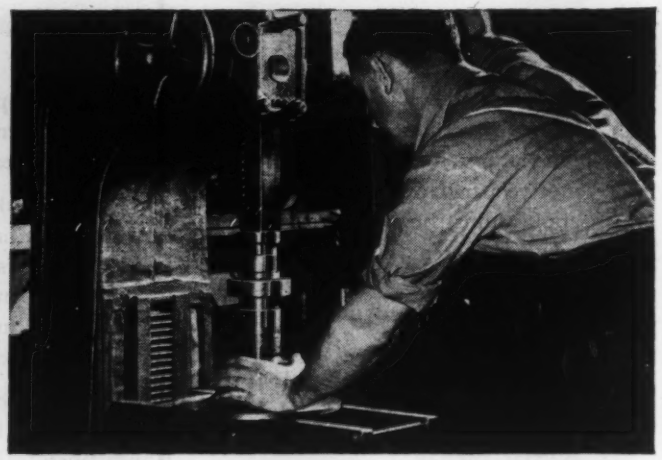
Torrington Needle Bearings Save Space and Give Dependable Service in Twin Disc Hydro-Sheave

The Twin Disc Hydro-Sheave Drive, made by Twin Disc Clutch Company, permits smooth acceleration and prevents stalling of electric motors and internal combustion engines. Efficient power transmission is secured with compact Torrington Needle Bearings.



Cross-section shows location of the Needle Bearing under the sheave. The compactness of this bearing, with its small diameter rollers and thin outer race, makes it ideal for this application. Its oil reserve capacity eliminates need for pressure lubrication.

The full complement of precision rollers, operating on a hardened and ground shaft, provides tremendous load capacity. This feature, combined with the low coefficient of friction, assures reliable operation and long, trouble-free service life.



Needle Bearings are easily installed with a simple arbor press operation. The bearing takes a firm press fit, and therefore requires no retaining devices. Thus, to the advantages of compactness and efficient operation are added speed and economy of assembly.

Many machines can be made lighter, sturdier, more compact and more efficient with Torrington Needle Bearings. Our engineers will be glad to help you adapt these high capacity bearings to your equipment. Write us today. THE TORRINGTON COMPANY, Torrington, Conn., or South Bend 21, Ind. District offices and distributors in principal cities of United States and Canada.

TORRINGTON *NEEDLE* **BEARINGS**

Needle • Spherical Roller • Tapered Roller • Straight Roller • Ball • Needle Rollers

the end of horse and buggy days

for stainless sheet and strip

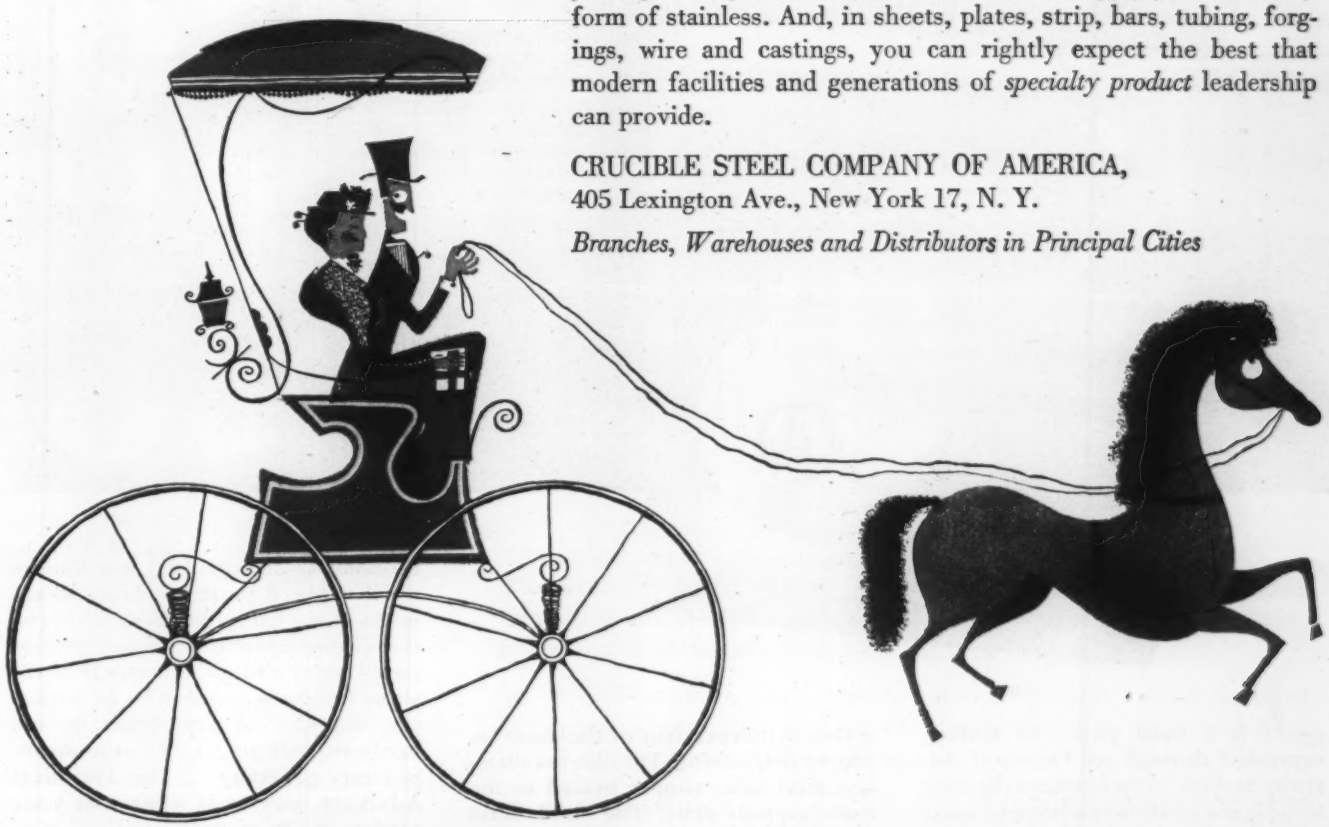
Automobiles were once designed as horseless carriages—even to the dashboard socket for a needless whip. Stainless steel production, too, once struggled thru horse and buggy thinking. More power, heavier rolls, more care in surface finish—and stainless sheet and strip came forth a step-child of carbon steel methods. Today's modern strip mills have changed this, giving stainless production new concepts of quality.

CRUCIBLE, one of the pioneers in stainless steel, has gone still further. Now, *for the first time*, hot and cold rolled stainless steel is made a *specialty product*, by specialty production methods, in a mill built specifically for this purpose—in widths from 1½" to 50" inclusive, and in all gauges, grades and finishes.

This is more than merely another source of supply. For, with this new mill at the Midland Works and the Trent Tube Co. joining the organization, CRUCIBLE can now supply you with *every* form of stainless. And, in sheets, plates, strip, bars, tubing, forgings, wire and castings, you can rightly expect the best that modern facilities and generations of *specialty product* leadership can provide.

CRUCIBLE STEEL COMPANY OF AMERICA,
405 Lexington Ave., New York 17, N. Y.

Branches, Warehouses and Distributors in Principal Cities



CRUCIBLE first name in special purpose steels

hot and cold rolled **STAINLESS SHEET AND STRIP**

STAINLESS • HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE • STEELS

Solid Brass combined with steel and aluminum in this quality lock set

Sargent Pin Tumbler Door Lock, in the 4500 Line of Precision-Built Lock Sets. Includes locking button in center of inside knob, and automatic deadlock. Made by Sargent & Company, New Haven, Conn.

Parts of the Sargent 4500 Line Lock Set. All exposed and most working parts are solid brass. Other metals include seamless steel tube, pressure-cast aluminum, steel springs and lock washers. Steel parts are rust-proofed.

It is a fixed policy of Revere, expressed through its Technical Advisory Service, to recommend the most suitable materials for each application, whether or not supplied by Revere. An outstanding example of this practice is to be seen in the Sargent 4500 line of Precision-Built Lock Sets, a new line of exceptional beauty, security, convenience and long life. Revere and Sargent collaborated closely on this and other Sargent products.

The lock sets have a number of important advantages. One is the self-aligning feature; there is an aligning tube of pressure-cast aluminum which makes it independent of the door for proper functioning. The case is a seamless steel tube, copper brazed to the front support plate. The solid brass lock mechanism has been simplified to achieve a small cross bore, permitting gracefully-designed knobs and roses in the proper proportions. The roses, incidentally, are applied without the usual screws, and there is no set screw in the knob. A new principle permits the knobs to project the same distance on each side, regardless of door thickness. The lock set is available in five different functions, each requiring the same size holes in the door, for the economy of standardized installation.

All exposed parts are brass as are many of the other parts—solid brass, the quality metal that assures permanent service and good looks in hardware. Revere is proud to be an important supplier of fine brass in the hardware industry, as well as to manufacturers generally . . . The Technical Advisory Service is always at your service, ready to give unbiased suggestions on materials, design and fabrication.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

* * *

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere.

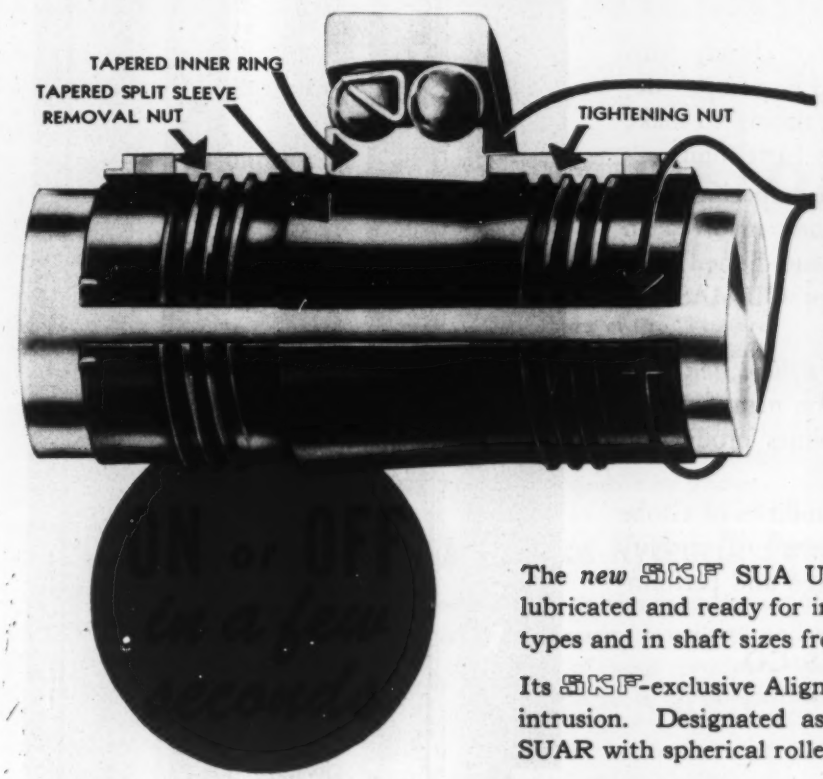
SOMETHING NEW!

SKF introduces the

SUA UNIT PILLOW BLOCK

featuring a tight fit between bearing and shaft

Here's How It Works



TIGHT FIT results when the tightening nut pushes the tapered inner ring over the tapered split sleeve.

CONCENTRIC GRIP is firm and positive—as the split sleeve contracts and wraps around the shaft. Removal is accomplished by reversing the process—with tightening nut loosened, removal nut pushes inner ring off the sleeve.

The *new* SKF SUA Unit Pillow Block is completely assembled, lubricated and ready for immediate use. Available in "free" or "held" types and in shaft sizes from $1\frac{7}{16}$" to $2\frac{7}{16}$".

Its SKF-exclusive Align-O-Seals prevent lubricant leakage and dirt intrusion. Designated as type SUA with ball bearings—and type SUAR with spherical roller bearings.

No exposed bearing . . . no lock screws to raise troublesome burrs on the shaft . . . the nut is locked to the sleeve . . . and even though the shaft vibrates, the concentric grip will not loosen.

For more information, check your local authorized SKF Distributor, or write: SKF Industries, Inc., Philadelphia 32, Pa. 6681

Bearings and pillow blocks engineered by **SKF**

Pump Barrels that "can take it"

—Plunger Travel Up to 160 Thousand Miles —100 Million Reversals

When oil men sink a pump a mile and more deep—it's got to be *tough* and *dependable*. *Tough* to withstand pressures up to 3 thousand pounds per square inch and shock loads of fifteen thousand pounds per square inch.

Dependable because at such depths there's no chance of maintenance. The only alternative is costly—pull up and replacement.

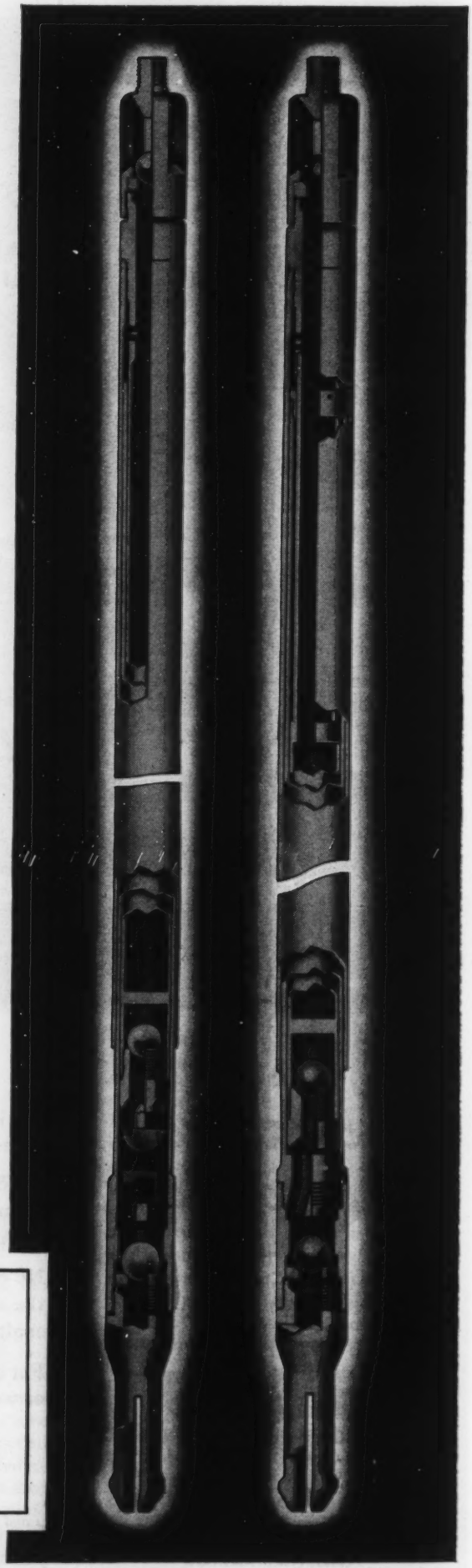
Globe Steel Tubes Company worked closely with the manufacturer of these OILMASTER pumps—developing the exact kind of alloy steel tubing to make these tough dependable oil well pump barrel units.

Globe fabricates these tubes to rigid specifications for the exacting conversion operations involved in producing a uniformly heat-treated and honed one-piece, long length barrel required for OILMASTER oil-well pumps.

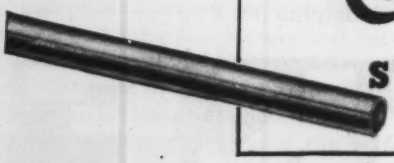
Result: *Users regularly report fifty million and more pumping cycles with no breakdowns!* The manufacturer, Fluid Packed Pump Company, simplifies production and gains a superior product.

Decide today to look into the possibilities of Globe Tubes for your products—to cut costs—to simplify production—to improve product design and performance. Write —

GLOBE STEEL TUBES CO.
Milwaukee 4, Wisconsin



Seamless Stainless Steel Tubes
Gloweld Welded Stainless Steel Tubes
Carbon—Alloy—Seamless Steel Tubes
Globeiron Seamless High Purity Ingot Iron Tubes
Globe Welding Fittings



GLOBE
STEEL TUBES

THEY FLOAT!

WHAT: ***bearings in a Pesco Hydraulic Pump***

WHY: ***to constantly maintain minimum end clearance***

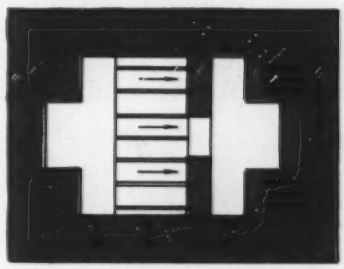
HOW: ***by means of "PRESSURE LOADING"***

RESULT: ***volumetric efficiencies up to 97%***
. . . torque efficiencies up to 90%

"Pressure Loading" is an exclusive, patented Pesco principle of construction for gear type hydraulic pumps. By *automatically* holding end clearance to a thin film of oil, maximum torque and volumetric efficiencies are obtained under all operating conditions. New pump efficiency is maintained throughout the long service life of the pump since "Pressure Loading" provides an *automatic* take-up of wear.

THIS IS "PRESSURE LOADING":

The schematic illustration at right shows the three principal parts of a gear type hydraulic pump. They are the bearings ("A" and "C") and the gear ("B"). Bearing "A" is fixed. Bearing "C" "floats". By means of the "Pressure Loading" principle, pressure from the discharge of the pump is transmitted through a "pressure loading" passage and is exerted against the rear of the "floating" bearing (arrows). This force is counterbalanced by the pressure developed within the gear cavity so that the thrust of the bearing against the gears is just enough to accomplish its purpose.



REMEMBER: *Only Pesco Hydraulic Pumps are "pressure loaded"!*

If your product uses, or can use the sales power of hydraulic power, be sure to get the full story of "Pressure Loading" and what it means to the efficient, economical operation of your product. Write for the booklet "Pressure Loading by Pesco". There is no obligation.

Pesco PRODUCTS DIVISION
BORG-WARNER CORPORATION
11610 Euclid Ave. · Cleveland 6, Ohio
MANUFACTURERS OF BW SUPERCHARGERS

Check

These 5 Big Advantages of the Garlock KLOZURE

1. The sealing element is tough and durable
2. It stays firm and resilient
3. It resists oil and heat
4. It is extremely sensitive and flexible
5. Garlock KLOZURES are made in many models and in a complete range of sizes*

*Including Metric O.D. to fit bearing manufacturers' standard bores.

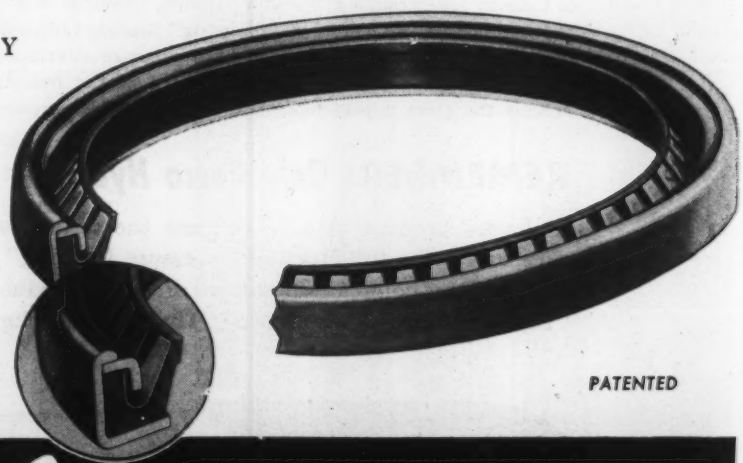
The sealing element in the Garlock KLOZURE Oil Seal is a special synthetic composition developed by Garlock to resist oil and heat. It is unaffected by temperatures up to 250° F. Also it is remarkably tough and durable—stays firm and resilient even after long service.

The unique tempered spring used in the new Models 53 and 63 KLOZURE is extremely sensitive and flexible. Each finger or lug is alive and each delivers independently its required light pressure to the tip of the sealing element.

Write for KLOZURE *catalog!*

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

Illustration shows Model 53 KLOZURE which is produced in a range of sizes for 3" to 10" shafts. Model 63 KLOZURES, employing the same engineering principles but differing in details of design, are made in a range of sizes from ¼" to and including 3" shafts.

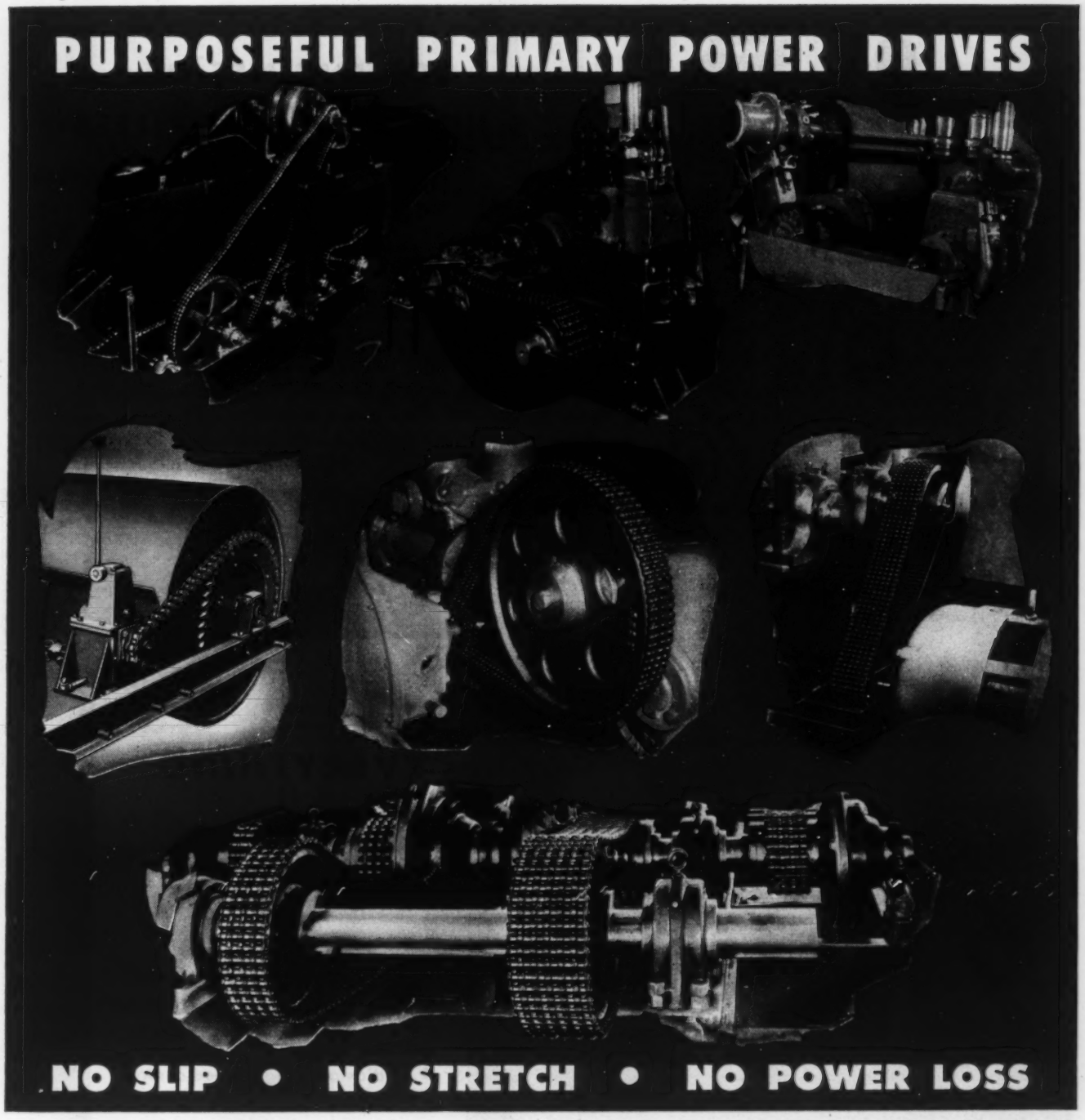


PATENTED

GARLOCK Klozure* OIL SEAL

*REG. U. S. PAT. OFF.

PURPOSEFUL PRIMARY POWER DRIVES



NO SLIP • NO STRETCH • NO POWER LOSS

Ideal as motor and engine drives, Diamond Roller Chains are positive and economical. They are rugged, compact, and light. They deliver at high speeds as well as at intermediate or low speeds, and rolling at every point of contact, are quiet in operation. Diamond Chains transfer power without waste, offering maximum economy. Maintenance, adjustments for stretch, replacement troubles are practically eliminated.

Not depending on friction, great tension is absent and there is no separating force as with gears. The result is greatly increased bearing life.

As a guide to appropriate Chain selection, refer to our latest Catalog 649. If you haven't a copy, we will gladly mail one on request.

DIAMOND CHAIN COMPANY, Inc., Dept. 435, 402 Kentucky Avenue, Indianapolis 7, Indiana.

DIAMOND ROLLER CHAINS

Offices and Distributors In All Principal Cities

FOR ENGINES OF
5 HORSEPOWER OR LESS

Specify

THE NEW ZENITH

"WORKHORSE"

The Rugged Lightweight
that has EVERYTHING

Because it's Built by

ZENITH

Leading manufacturer of carburetors for tough jobs

- High angularity design
- Adjustable high speed control
- Reasonably priced
- Flexible through wide range of applications
- Adjustable idling control
- May be balanced so air cleaner has a minimum influence on fuel-air ratio

For over 40 years Zenith has designed and built heavy-duty carburetion equipment, famous for its uniform high quality and efficiency. Now, Zenith has turned all of this know-how to the development and perfection of the ideal carburetor for engines of 5 horsepower and under. The result is the versatile "Workhorse". Its high angularity design assures efficient operation in positions ranging through a wide arc away from vertical. Compactness, simplicity and unsurpassed performance are just a few of the many other advantages afforded by the new "Workhorse". Specify this Zenith* carburetor for your engines and you, too, will agree—it's the rugged lightweight that has *everything*!

*REG. U. S. PAT. OFF.

ZENITH CARBURETOR DIVSION of
696 HART AVE., DETROIT 14, MICHIGAN

Bendix AVIATION CORPORATION

MANUFACTURERS OF FINE CARBURETORS AND FUEL FILTERS

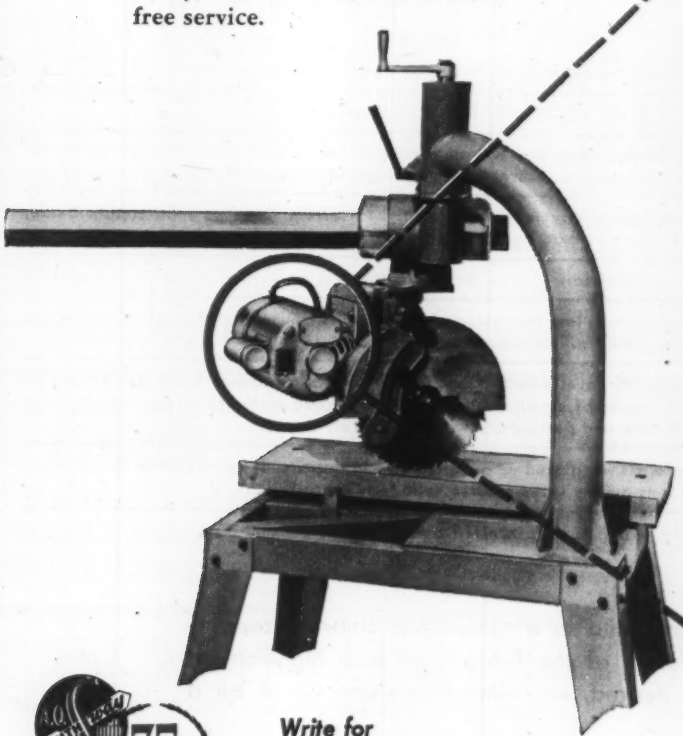
A.O. Smith Builds ELECTRIC MOTORS

for hundreds of products, including Mooradian Swing, Table, and Radial Saws

At A. O. Smith, where research itself has long been "big business," our research and engineering staff is at your disposal—to help integrate electric-motor design with your product design.

Typical of the many problems A. O. Smith has solved in engineering electric motors to specific product requirements is that of Mooradian Manufacturing Co., whose multi-purpose radial saw is pictured here.

If you are seeking improved performance in your product, or if you require special characteristics in your power component—in standard or custom-built motors—consult the A. O. Smith man. SMITHway Electric Motors are designed and built to bring to each application the maximum in compactness, safety, convenience, and trouble-free service.



MOORADIAN PORTABLE RADIAL SAW, product of Mooradian Manufacturing Co., Los Angeles 11, does the work of six machines. It has a wide range of uses, including compound miters. The operator can "gang-up" long pieces to cut multiple parts. Belt drive permits choice of many speeds not obtainable with direct-drive saws.

Says C. C. Compton, Mooradian general manager: "We especially prefer and recommend SMITHway high-speed motors because they are lighter in weight, less bulky, very powerful, and vibrationless. They deliver when the going gets tough, and make good clean cuts. They are ideal for woodworking equipment. We use them exclusively on our complete line of swing, table, and radial saws."

SMITHway ELECTRIC MOTORS for Mooradian Saws are 3450 rpm, single-phase, 115/230 v., capacitor start, ½, ¾, 1, and 1½ hp. Light, compact, with high break-down torque, they have pre-lubricated, shielded ball bearings self-protected from sawdust and dirt. Modern SMITHway design makes them highly suitable for today's modern tool and machine designs.

ask the A. O. Smith man about electric motors for both standard and special uses

Write for Bulletin No. EM-152

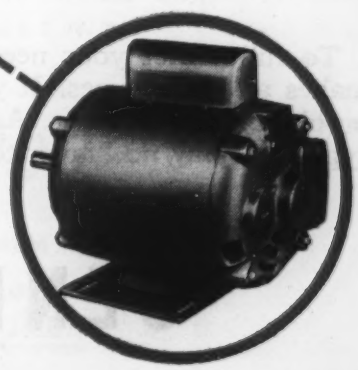
75th ANNIVERSARY 1874 · 1949

A. O. SMITH Corporation

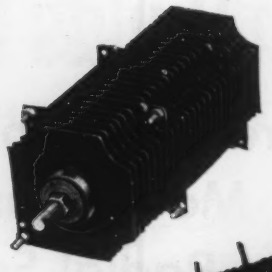
New York • Boston • Cleveland • Atlanta • Chicago
Detroit • Milwaukee • Houston • Tulsa • Dallas • Denver
Seattle • Los Angeles • San Francisco • Motor Export
Department: 13 East 40th St., New York 16

24-HOUR MOTOR SERVICE

The A. O. Smith Product Service Division provides fast, low-cost electric-motor service to more than 200 authorized service stations, on a 24-hour, off-the-shelf basis. Factory Service Branches and Warehouses at Union, N. J., Chicago, Los Angeles.



And which Metallic Rectifier Is Best?



copper-oxide

low-voltage selenium

high-voltage selenium

No one type is "best." Each type of rectifier has characteristics which make it a "natural" for a particular application. For every application there is usually one best type. The correct choice depends upon the application. Here are general recommendations!

GENERAL RECOMMENDATIONS

Where you want	*Use*	*Because*
Small size	High-Voltage Selenium	Except for 12 volts and below, fewer high-voltage selenium cells are needed.
Light Weight	High-Voltage Selenium	Selenium-on-aluminum cells are much lighter than copper-oxide.
High Power for a few seconds	Copper-Oxide	Both types will withstand high short-time *current* overloads but only copper-oxide will withstand the higher a-c voltage necessary to deliver short-time high power output.
High current with Low Voltage	Fan Cooled Copper-Oxide	While with fan cooling, selenium can operate at higher current densities than copper-oxide, efficiency will be lower. Copper-oxide aging remains stable.
High Voltage	High-Voltage Selenium	Fewer selenium cells are required.
Low Current at 6 volts or less	Copper-Oxide	Cell for cell, copper-oxide costs less than selenium. Where the minimum number of cells of either type is required, copper-oxide will be cheaper.
Long life with unchanged output	Copper-Oxide	While both types appear to have unlimited life. Characteristics of copper-oxide do not change after the first 6 to 12 months of continuous operation. Selenium continues to age—to build up internal resistance with time and particularly with high current densities.
Blocking in D-C Circuits	Copper-Oxide	Selenium tends to "unform" when used as a check valve in d-c circuits or when idle for a period of time (though it reforms quickly when reverse voltage is impressed).
Resistance to Corrosive Atmosphere	Oil-Filled Selenium	Stacks are hermetically sealed in oil, protected against fumes, dirt and dust.

Low-voltage selenium is generally recommended as a compromise between copper-oxide and high-voltage selenium. Where some of the features of both high-voltage selenium and long life copper-oxide are desired, low-voltage selenium would be a logical choice.

To fully meet your needs General Electric makes all three types. If you have a rectifier problem, bring it to us. As we make all three types, we play no "favorites." You can expect an impartial recommendation. Contact your G-E Apparatus Agent or write *Apparatus Dept., General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

456-14

WANTED: *A better metal for water pump shafts.*
Working conditions bad...no vacations...
hard physical labor...long hours.

THE TWIN COACH COMPANY
KENT, OHIO

"K" Monel-shafted bus water pump, manufactured by the Sherwood Brass Company of Detroit, Mich. for the Fageol Products Company, Kent, O.

Position Filled by "K" Monel*

Yes...it's a tough job, being a bus water pump shaft. Most metals don't last long at it, as any maintenance man will testify.

That was the situation at the Twin Coach Company. Water pump shafts in their buses were failing with monotonous and costly regularity. Then one day they asked the Fageol Products Company—if something couldn't be done about it.

Something could. The Fageol Products Company came through handsomely. Twin Coach's pumps are now equipped with "K"* Monel shafts...and things are looking *up* in the maintenance department.

Mr. A. G. Hilf, Vice President in charge of production at the Fageol Products Company explains it this way:

"'K' Monel was chosen for water pump shafts because:

1. *It is corrosion resistant.*
2. *It can be heat-treated to secure satisfactory hardness.*
3. *It expands only slightly during extreme variations in water temperatures.*
4. *It has high resistance to corrosive mineral salt deposits encountered in some localities.*

"This combination of desirable characteristics should result in greatly increased service life and much reduced maintenance in 'K' Monel-shafted pumps."

Because of its unusual properties, "K" Monel has an excellent service record in a wide range of industrial "task" applications. In fully age-hardened condition, "K" Monel has a minimum yield strength of 100,000 psi, and a tensile strength of over 140,000 psi. Cold-drawn, age-hardened "K" Monel has a Brinell (3000 kg) hardness of 265—320. In addition, this alloy is rustproof and resistant to most commonly-encountered corrosives. And of particular importance in vehicular applications, "K" Monel offers high resistance to fatigue failure.

For further information, ask for Bulletin T-9, *Engineering Properties of "K" Monel.* Remember, too, that our Technical Service Department is always ready to help with your specific metal-selection and fabrication problems.

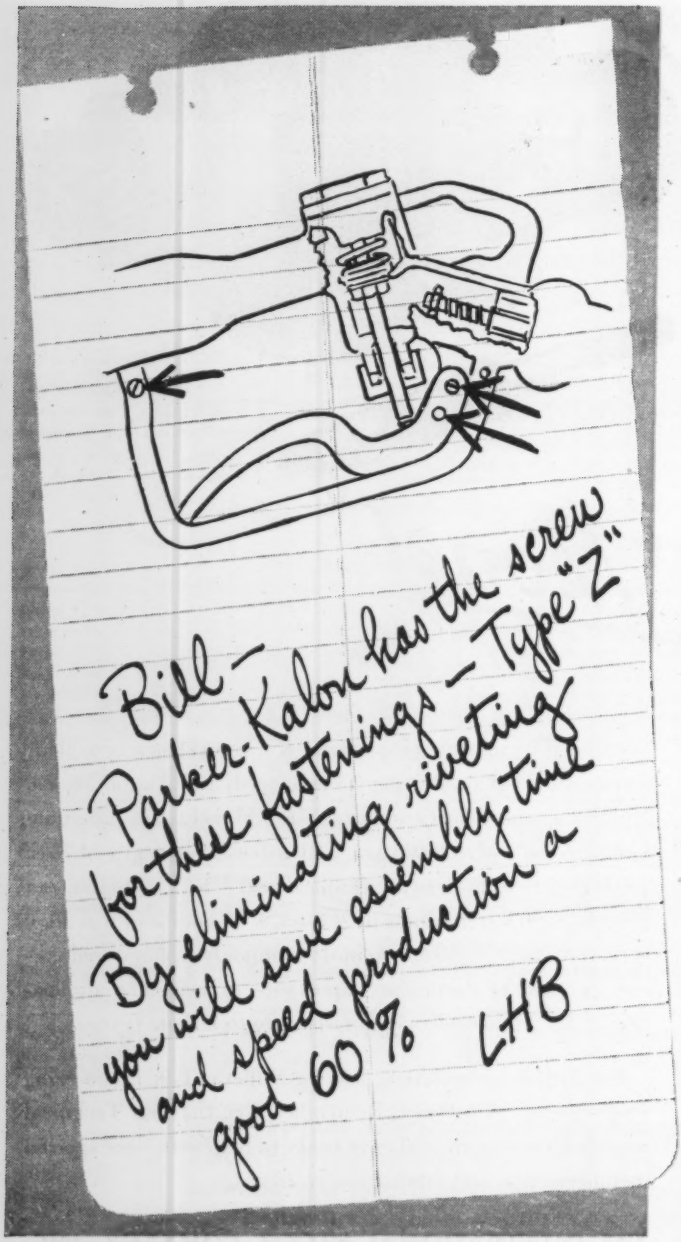
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

*Reg. U. S. Pat. Off.

Monel*...FOR MINIMUM MAINTENANCE

EMBLEM OF SERVICE
INCO
TRADE MARK

TO CUT ASSEMBLY COSTS...
fit the fastener *to the job*



IT CAN BE costly to assume that the presence of metal *assures* a means of good fastening. The screw designed and built for sheet metal .050″ to .200″ thick is not the most efficient fastener for sheets or plates over .200″ thick.

To avoid fastening failure, to prevent assembly stoppage . . . to hold production costs to the minimum, *fit the fastener to the job.*

Parker-Kalon alone offers a complete line of Self-tapping Screws (the most economical fastener) for every metal and plastic assembly. P-K Assembly Engineers thus can recommend, without bias, the type of fastener that best serves the application. That's why . . .

more Fastening-wise Manufacturers call on Parker-Kalon

Look at all these other advantages . . .

MORE Know-How — Parker-Kalon originated the Self-tapping Screw and has been the leader with new designs ever since.

MORE "Show How" — P-K's staff of Assembly Engineers has helped solve nearly a million application problems.

MORE Exacting Quality Control — P-K's investment in laboratory testing and inspecting equipment is unsurpassed.

MORE Production — Parker-Kalon is the world's leading manufacturer of Self-tapping Screws.

MORE Top-Rated Distributors — Everywhere throughout the nation P-K Self-tapping Screws are readily available.

PROMPT DELIVERIES from stock on most types and sizes.

LET A P-K ASSEMBLY ENGINEER HELP YOU simplify your product's assembly and avoid unnecessary production costs by fitting the fastener to the application. Often, he can save you the necessity, and expense, of using special fasteners. If you prefer, mail assembly details for recommendations. Parker-Kalon Corporation, 200 Varick St., New York 14, N. Y.

REMEMBER . . . IF IT'S *P-K* . . . IT'S *O.K.!*

P-K®

The Original

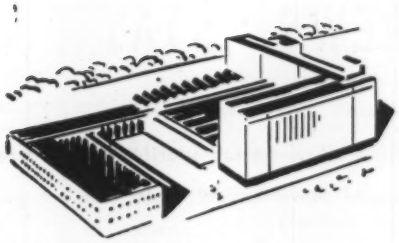
PARKER-KALON SELF-TAPPING SCREWS

FOR EVERY METAL AND PLASTIC ASSEMBLY

P-K Also Makes
Cold-forged

OTHER P-K PRODUCTS: Cold-Forged Socket Screws, Wing Nuts, Thumb Screws • Hardened Screwnails and Masonry Nails • Shur-Grip File and Solder Iron Handles • Metal Punches • Damper Regulators and Accessories

Buy screw machine parts from Alcoa—
the men who know the metal best



Complete facilities under one roof

Alcoa Aluminum screw machine parts give you strength with light weight, close tolerances where required, added sales appeal for your product.

Aluminum screw machine parts made *by Alcoa* give you even more: the know-how of the organization that pioneered aluminum in automatic screw machines; aluminum-trained experts who offer engineering, alloy choice and finish selection counsel —at no added cost to you.

You get all these plus competitive prices and dependable delivery.

Your Alcoa sales representative will be glad to give you complete information on our capacity, and a prompt quotation. Or write ALUMINUM COMPANY OF AMERICA, 676G Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA

ALCOA ALUMINUM SCREW MACHINE PRODUCTS

INGOT • SHEET & PLATE • SHAPES, ROLLED & EXTRUDED • WIRE • ROD • BAR • TUBING • PIPE • SAND, DIE & PERMANENT MOLD CASTINGS • FORGINGS • IMPACT EXTRUSIONS
ELECTRICAL CONDUCTORS • SCREW MACHINE PRODUCTS • FABRICATED PRODUCTS • FASTENERS • FOIL • ALUMINUM PIGMENTS • MAGNESIUM PRODUCTS

The patented Knurled Cup Point of this popular "UNBRAKO" Socket Set Screw makes it a Self-Locker, because the edges of the counter-clockwise knurls positively prevent creep, regardless of the most chattering vibration. *"It won't shake loose!"*
Pat. & Pats. Pend.

The patented Knurled Threads of this "UNBRAKO" Socket Set Screw are swaged—making it a most excellent Self-Locker for applications requiring cone, oval, flat or other points except cup, and for use with hardened shafts. *"It won't shake loose!"* *

UNBRAKO

SELF-LOCKING SET SCREWS

KNURLING MAKES THESE SET SCREWS "STAY PUT"

"... They Won't Shake Loose"—that's why more and more manufacturers are specifying these screws to reduce downtime and repair costs ... to increase production, speed deliveries and protect customer goodwill.

Their exclusive *knurling* makes them exceptionally vibration-resistant, prevents "creep" and subsequent loosening of the screws. They "stay put", even under the most chattering vibration.

UNBRAKO *Self-Locking* Set Screws can be real "Vibration Insurance" for *your* production machinery. And remember, they make an impressive selling point when you use them on your finished products. Our folder 658-1 gives you further details. Write for yours today!

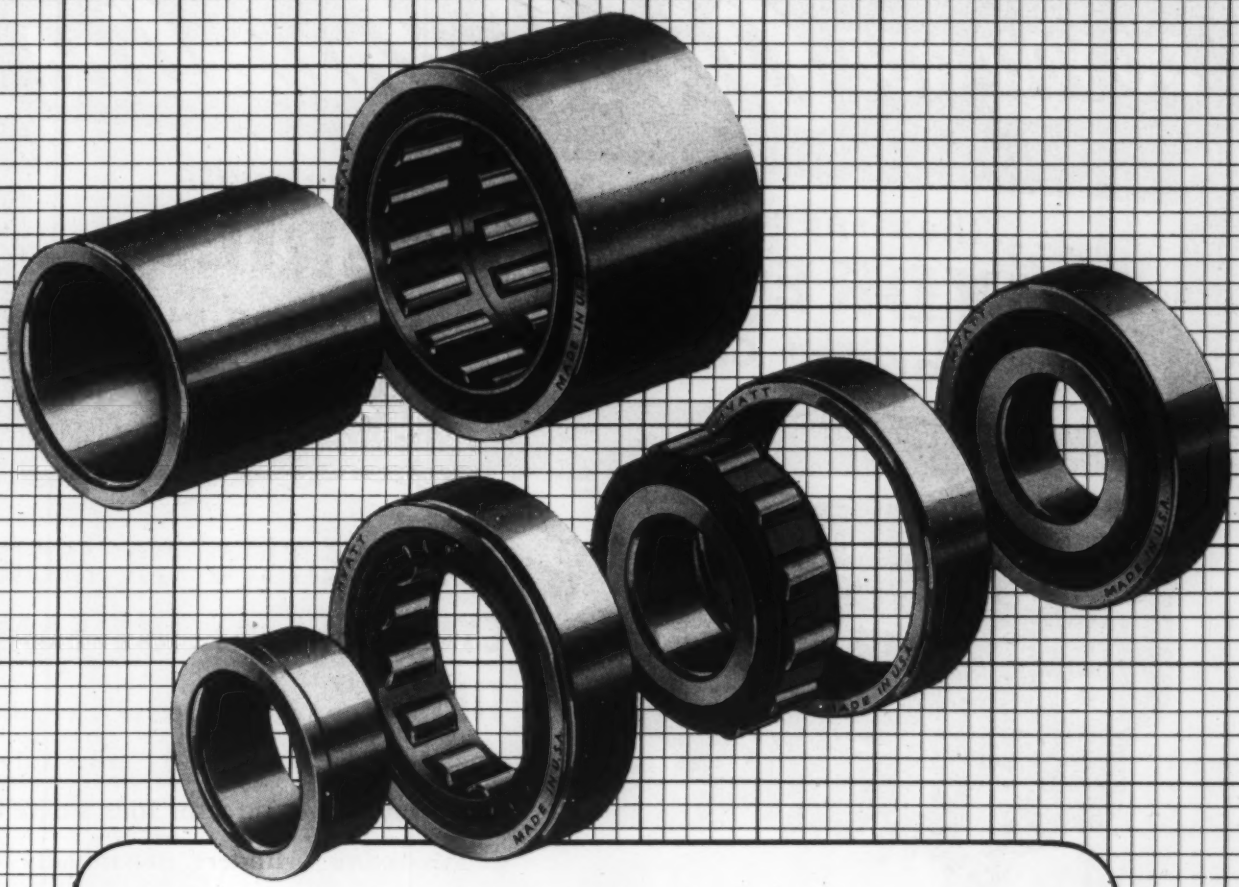
Knurling of Socket Screws originated with "Unbrako" in 1934.

**These screws are not carried in stock. Prices are available on application.*

SPS **STANDARD PRESSED STEEL CO.**

BOX 102, JENKINTOWN, PENNSYLVANIA

"Serving Industry continuously since 1903 through Industrial Distributors"



For High Capacity... HYATT Hy-Loads

High carrying capacity is just one of the many advantages of Hyatt Hy-Load Roller Bearings. Others include: complete interchangeability of separable parts, option of omitted race operation, adherence to standard AFBMA dimensions, more than 500 sizes—in two diameter series, wide and narrow widths.

Where loads are tough and service is rough, Hy-Loads deliver the smooth, sweet, trouble-free performance that means years and years of satisfaction in machinery and equipment of all types.

In mills and factories . . . on farms . . . oil fields . . . railroads . . . highways and skyways Hy-Loads are daily proving that better bearing design means better machine design and performance. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

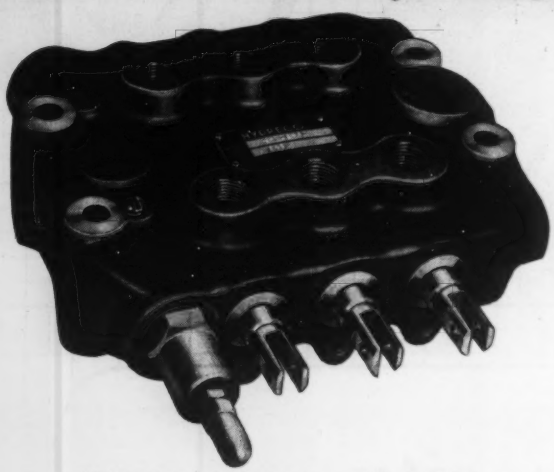
HYATT ROLLER BEARINGS

DO YOU USE *Oil Hydraulics?*

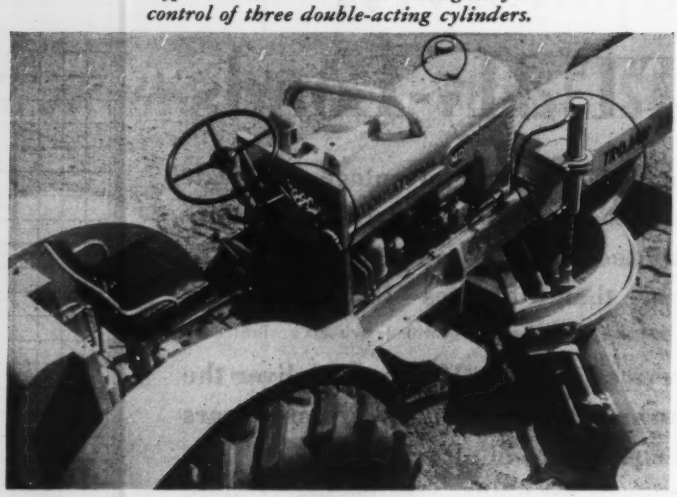
...then speed up hydraulic control with

HYDRECO V13 SERIES

Parallel Circuit Control Valves



Typical V13 Series Valve—designed for control of three double-acting cylinders.



Hydreco Double-Acting Cylinders and Hydreco Oil-Hydraulic Gear Pump handle the rest of the Hydraulic Control Job.

OPERATE TWO OR MORE CYLINDERS AT THE SAME TIME

.... providing pressure requirements are the same—V13 Series Valves will operate two, three or four single or double-acting cylinders individually or all at the same time.

On this new model Trojan Welterweight Patrol, manufactured by CONTRACTORS MACHINERY COMPANY, the scraper blade can be raised, lowered or tilted quickly by controlling the positioning cylinders either *individually* or *together.*

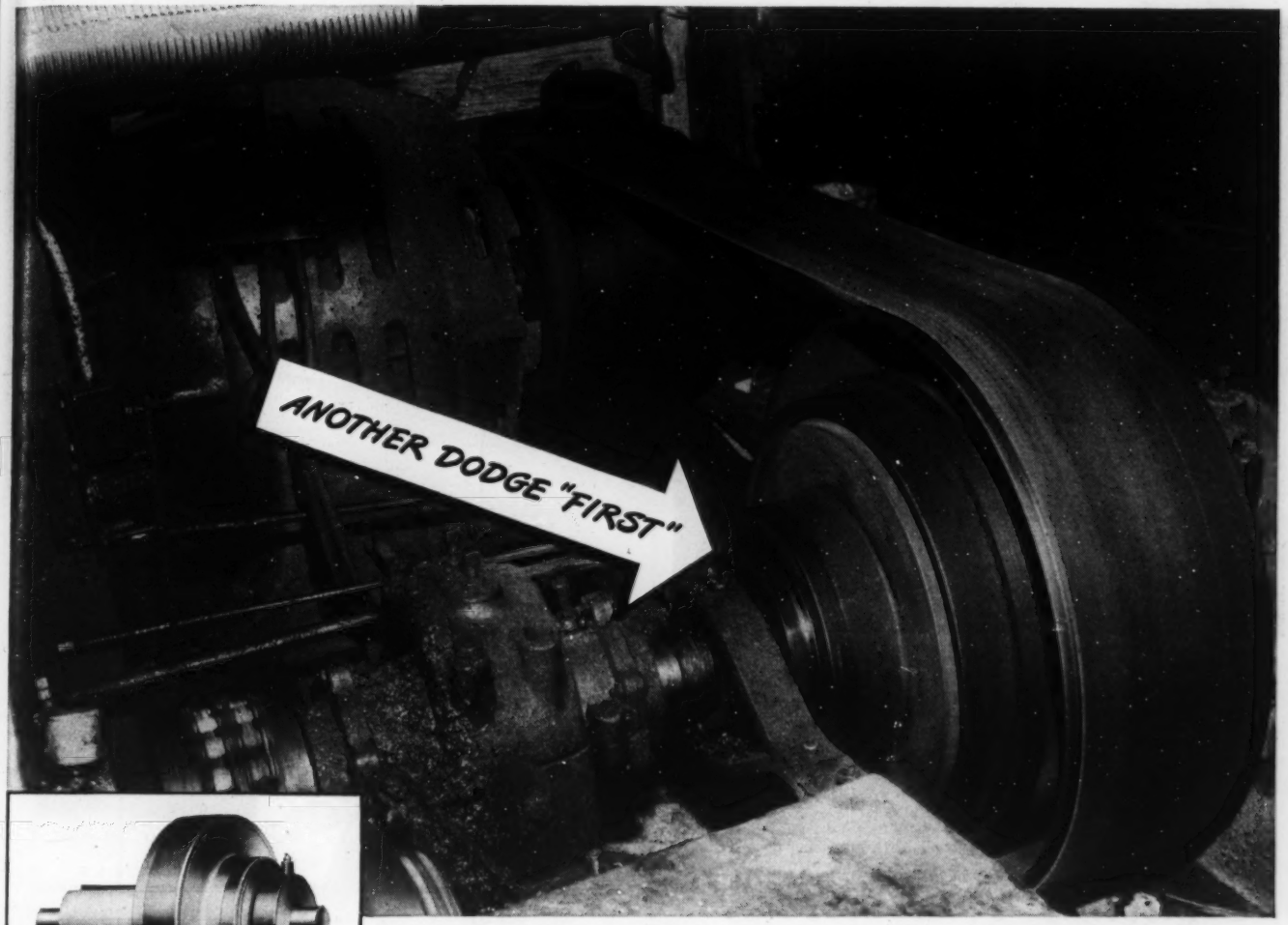
Another example of how the *Hydreco V13 Series* Valve can be used to improve hydraulic control.

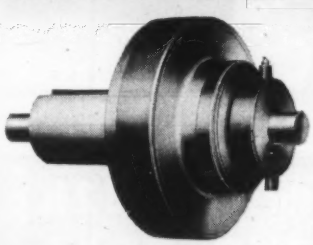
Quality in design... *Quality* in product

Write for Catalog and Full Information

HYDRECO
HYDRAULIC CONTROL DEVICES
PUMPS · CYLINDERS · VALVES

HYDRAULIC EQUIPMENT COMPANY
1106 EAST 222nd STREET • CLEVELAND 17, OHIO





Over 50 years of experience in the manufacture of industrial clutches have gone into the development of the famous Dodge Diamond D Friction Clutch — noted for its ruggedness and simple, one-point adjustment.

"SHOCK" TROUBLE?

Here's one way to lick it!

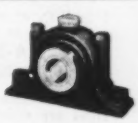
HERE A Dodge Diamond D Clutch takes the tremendous shock loads of a veneer peeler lathe. Huge logs are revolved and "peeled" by knives, with 150 to 200 engagements per hour! Precision-built clutches, capable of performing dependably where profits depend upon uninterrupted operation, are another Dodge "first"—one of many Dodge "firsts" in the field of power transmission machinery.

For information on how Dodge products can improve machine performance, save power and keep production steady, call the Transmissioneer, your local Dodge Distributor. He has information on new and better developments for the mechanical transmission of power.

DODGE MANUFACTURING CORPORATION • MISHAWAKA, INDIANA

TAPER-LOCK SHEAVE
Simplest, surest mechanism ever devised for holding wheels to shafts.

DODGE-TIMKEN BEARINGS
save power on millions of industry's toughest jobs.



ROLLING GRIP CLUTCH
No toggles! Compact. Extreme flexibility with positive drive.

TAPER-LOCK FLEXIBLE COUPLING
Available from stock ready to install *without reboring!*

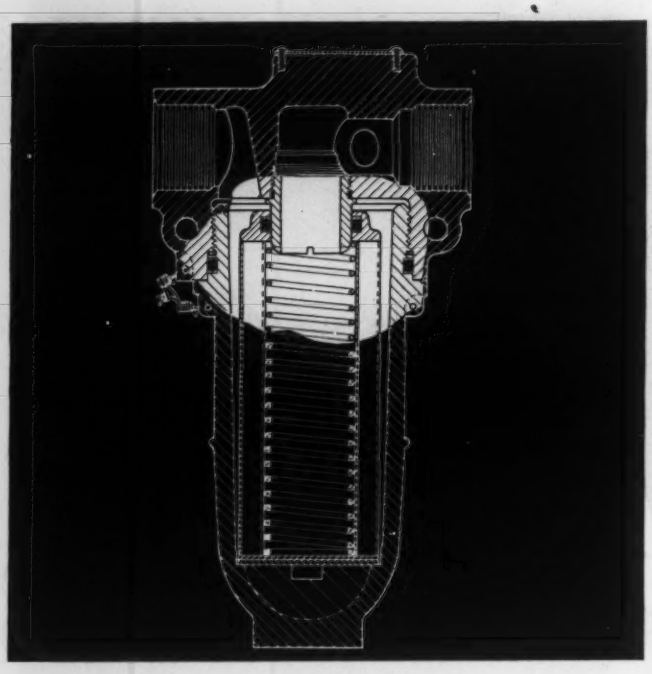
FIRST IN POWER TRANSMISSION MACHINERY!

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER
—graduate of a Dodge factory course, qualified to help on your power transmission problems. Look for his name under "Power Transmission Equipment" in your classified telephone book

NAME PLATES

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, ETCHING COMPANY OF AMERICA, 1520 MONTANA STREET, CHICAGO 14, ILLINOIS



LINEAR

"O" Rings....

Sealing Unlimited!

Yes, LINEAR "O" rings give unlimited sealing performance whether installed in aircraft units flying at high altitudes or operating in a thousand-and-one different installations on the ground. After exhaustive tests, Purolator Products determined that LINEAR "O" rings, used in their automotive and aircraft filters, are resilient and tough enough to fully withstand shock and vibration as well as extreme pressures and temperatures.

Purolator's new aircraft hydraulic filter illustrated here uses LINEAR "O" rings to resist pressures as high as 4800 p.s.i. and temperatures from as low as minus 68°F. to as high as plus 280°F. Purolator's experience is a good example of the versatility, reliability and simplicity effected with LINEAR "O" rings.

In addition to a long list of natural or synthetic rubber compounds adaptable to a wide range of temperatures, gases and liquids, LINEAR is successfully moulding "O," "V," "U" or other shapes of Kel-F, Teflon and Silicone for special applications. These special materials are suitable for seals from minus 320°F. to plus 400°F. against concentrated sulfuric, hydrofluoric, hydrochloric and other vigorous oxidizing materials.

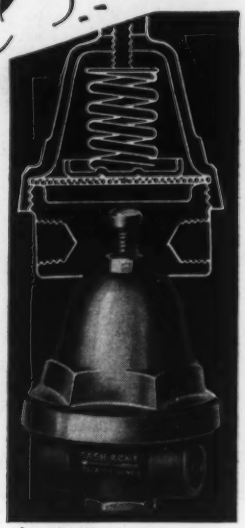
For your individual packing design or application, CALL LINEAR.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA.

GETTING DOWN TO SIZE WHEN THERE ARE SPACE LIMITATIONS...



Small-size reducing valves will be developed especially to fit your equipment. Use our 25 years of successful experience in manufacturing Automatic Valves!

CASH-ACME

A. W. CASH VALVE MFG. CORP.

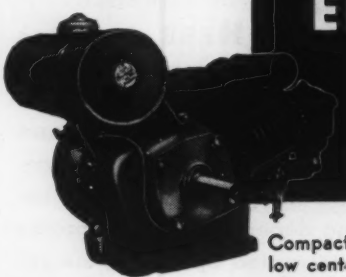
6613 EAST WABASH AVENUE — DECATUR, ILLINOIS, U. S. A.

CONTINENTAL MOTORS — AMERICA'S STANDARD

Let these 1½ and 2 h. p.

RED SEAL ENGINES

BUILD GOODWILL FOR YOU, TOO



Where height is critical, specify
AA-7
(1½ H.P. at 2600 r.p.m.)
or
AA-7B
(2 H.P. at 3200 r.p.m.)

Where horizontal dimensions are critical, specify
AU-7
(1½ H.P. at 2600 r.p.m.)
or
AU-7B
(2 H.P. at 3200 r.p.m.)

●

Heavy-duty 6-to-1 reduction gear mounting in any of 4 positions, also available.

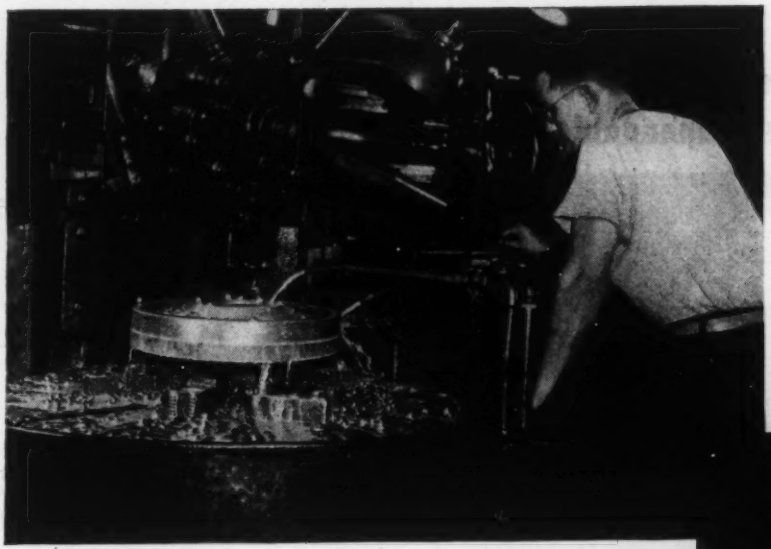
Compactness, balance, and extremely low center of gravity adapt these engines to an unusually broad range of applications, a range widened further by the fact that identical performance characteristics are available in models of differing profile and shape.

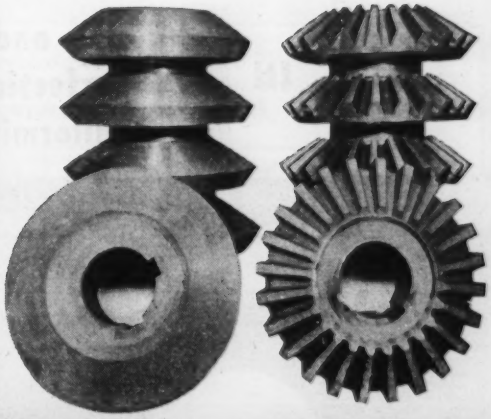
Torque substantially higher than in other engines of their ratings assures ample reserve power for suddenly-applied loads. These Red Seals cost less to run, and run longer without service, because their full rated horsepower is developed at moderate speed.

Let these products of Continental Motors, engine specialists for nearly half a century, help sell your product — help KEEP it sold. Installation drawings and full information on request.

Continental Motors Corporation

620 FORD BUILDING, DETROIT 26, MICHIGAN





FORMULA FOR A

GOOD GEAR BLANK

At Bethlehem, the formula goes something like this: GOOD steel, GOOD processing, GOOD machining . . . plus closest metallurgical controls through the critical steps of manufacture.

This combination, topped off by rigid inspection service, means high-quality gear blanks. The steel for these blanks is drawn from selected heats; upsetting, forging, and rolling are done in a three-way mill that combines these operations, imparting homogeneity and good grain structure. Each piece is given a rough machining before it leaves our plant—a step that saves time and expense for the customer.

If you make spur, herringbone, bevel, or miter gears, we suggest you thoroughly investigate Bethlehem blanks. They have so many excellent features; for instance, their high strength frequently makes possible thinner sections, thus affording savings in weight. They are available in carbon or alloy steel, treated or untreated; sizes range from approximately 10 in. to 42 in. OD.

Gears are but one of the many types of products that can be made from these rolled-and-forged circular blanks. For more information, request illustrated Booklet 216. We'll be glad to send you a copy free.

BETHLEHEM STEEL

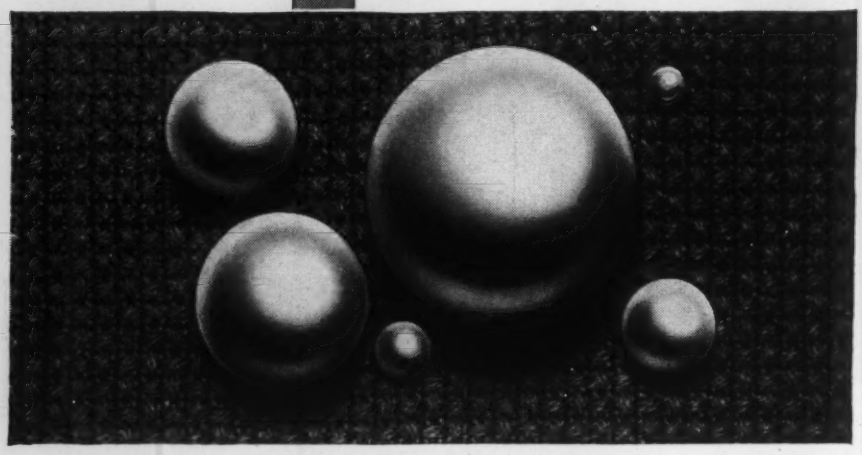
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM ROLLED-AND-FORGED CIRCULAR PRODUCTS

IN size and spherical accuracy
perfection of surface
uniformity—dependable physical quality



NOT A BETTER BALL MADE . . .

And the service results from every Strom metal ball prove it—not only in the finest precision ball bearings but also in the lot of other ball applications where Strom balls are doing the job better.

Strom has been making precision metal balls for over 25 years for all industry and can be a big help to you in selecting the right ball for any of your requirements. In size and spherical accuracy, perfection of surface, uniformity, and dependable physical quality, there's not a better ball made.

Strom STEEL BALL CO.
1850 So. 54th Ave., Cicero 50, Illinois
Largest Independent and Exclusive Metal Ball Manufacturer

More and More DESIGN ENGINEERS *say* CHECK WITH ATLANTIC

Because Atlantic Metal Hose does the job better than specified.

To Atlantic's engineering department, every order is a challenge to outdo specifications. That is why every length of Atlantic flexible metallic hose is *job tested and guaranteed to do its job.*

Whatever the problem—conveying gases, liquids or light and semi-solids under extremes of pressure, temperature and vibration . . . vibration absorption . . . connecting misaligned fixed structures . . . mobile service—you may be certain that either in current stock (the largest in the world) or in Atlantic engineering, there is a flexible metallic hose to answer the problem.

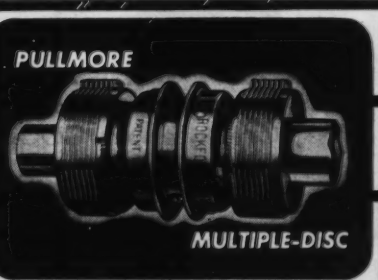
Write for our latest bulletin.

ATLANTIC METAL HOSE CO., Inc.
118 West 64th Street, New York 23, N. Y.

Let Us Help Solve Your CLUTCH Problem

Learning Your Clutch Needs
Analysing the Problem
Designing the Clutch
Planning Production
Tooling Up
Manufacturing
Checking and Testing
Supervising Installation
Servicing

Automotive and Aircraft
Trucks and Buses
Tractors and Road Machines
Farm Machines and Implements
Oil Field Rigs and Pumps
Industrial
Mowers and Light Machines
Engines and Marine Units
Machine Tools Production Units



ROCKFORD CLUTCHES

Here at Rockford, our clutch engineers work closely with the engineering departments of our customers — to develop the most practical, efficient and economical power transmission and control for their needs. Recently, this close cooperation was responsible for the development of a double-plate, over-center type clutch that has made "live power take-offs" practical for use in many industries in which they never were employed before. We would be pleased to show you how the design and construction advantages of ROCKFORD CLUTCHES and POWER TAKE-OFFS can help make YOUR product operate more efficiently, reliably and economically.

ROCKFORD CLUTCH DIVISION
BORG-WARNER
311 Catherine Street, Rockford, Illinois

To Top Flight Development, Design and Instrumentation Engineers:

This table gives the characteristics of Arma Two-Phase Induction Motors. The information may suggest applications of these components to your designs.

Type	Field Voltages		No Load Speed	Max. Watts Output	Stalled Torque	Rotor Inertia	Weight
	Main	Control	R.P.M. (Min.)	@ R.P.M.	Oz. In. (Min.)	Oz. In.^{2}	(Lbs.)
1A60	40	40	3200	1.5 @ 1500	1.7	0.03	0.8
1B60	115	115	3000	2.4 @ 2000	3.0	0.25	1.4
1D60	115	115	3000	6.4 @ 2150	8.0	0.25	1.4
1E60	115	110	3000	6.0 @ 2000	7.5	0.04	1.5
*1A400	115	115	9800	1.6 @ 5300	0.9	0.03	0.8
5A	75	90	3000	6.3 @ 1800	8.0	0.32	4.0
†5C	90	75	3000	7.5 @ 2000	8.0	5.51	4.3
6	115	90	3000	18.0 @ 2000	17.0	1.38	9.8

Operating Ambient Temperature Range 0°C to 55°C.
Reversible Rotation. 2 Phase. 60 Cycle.
**400 Cycle Unit. †High-Inertia Rotor.*

These Two-Phase Induction Motors Extend the Possibilities of Precision Instrumentation

Arma Corporation designed and built them for use in some of the highest-precision control systems, electromechanical computing systems and servo mechanisms ever devised. Long unpublicized because of security restrictions, many engineers are yet to have their first opportunity to consider new applications of these motors.

Response of Arma Induction Motors is Phenomenally Rapid

Full-Speed reversing in as little as three one-hundredth second characterizes the unusual acceleration and deceleration of Arma Induction Motors. This derives from the high torque-to-inertia ratio reflected in the table of characteristics. Such rapid response might well set new standards of automatic operation for industrial processes too complex to be trusted to manual operation.

Other Advantages of Arma Induction Motors

No Preferred Positions. Symmetrical rotor design eliminates all "clogging" or slot effects.

High Mechanical Accuracy. Extremely close tolerances make possible precise assembly and complete interchangability.

Minimum Inductive Interference. Stray fields are low, larger types are shielded.

Arma Induction Motors are designed to minimize the possibility of damage by shock or corrosion. They are nearly noiseless in operation. All types have double shaft extensions.

Use These Other Arma Components, Too

Investigate possible applications of these other Arma components released for private industry: Tachometer-type Induction Generators for high-performance servo systems; Electrical Resolvers* for solving problems involving triangles, coordinates and vectors; Synchro Units for remote control and indicating purposes; high-precision Mechanical Differentials for computing applications.

How Ideas Become Realities

For over 30 years Arma Corporation has been quietly taking on (under wraps) one complex development and design problem after another for the U. S. military establishments—problems concerned with instrumentation. In the initial stage these problems may be little more than a gleam in someone's eye, a vague hope, a "dream"! That's where Arma *starts.* When Arma *finishes,* the problem is not only solved but the actual equipment to do the job, *built*—whether it be a complicated gun director, a gyro compass or a complex remote control system. Arma follows through to practical realities.

You are invited to request whatever information you may need to explore the possibilities of making use of any Arma product which has been released from security restrictions.

ARMA CORPORATION

254 36th STREET, BROOKLYN 32, N. Y.

SUBSIDIARY OF AMERICAN BOSCH CORPORATION

ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* • ARMA SYNCHROS • ARMA INDUCTION MOTORS • ARMA INDUCTION GENERATORS • ARMA MECHANICAL DIFFERENTIALS • ARMA ALTERNATING VOLTAGE COMPARATOR • COMPUTING MECHANISMS • INDUSTRIAL CONTROLS • STABILIZATION DEVICES • NAVIGATIONAL EQUIPMENT • LIMITRON AUTOMATIC INSPECTION SYSTEM

*Licensed for use under Arma patents Nos. 2,463,324 and 2,467,448. License information available.

QUALITY ARMA INSTRUMENT PRECISION

KINNEY Clutch Specialists

are ready to serve YOU...

Kinney Clutch Specialists can help you get the best clutch for the job and the most clutch for your money. Our designers and engineers will work with you to make sure every clutch—whether custom-built or standard design — gives efficient service. Remember, the correct type of clutch that's sized right and installed right will increase the safety and performance of your machinery.

Why not put this specialized clutch know-how to work on your clutch problems? There's a custom-built or standard design Kinney Clutch for every operating requirement: Interchange, Overrunning, Dry Plate, Oil Type, Fractional Horsepower, and Worrall. Write today for recommendations — send blueprints and specifications.

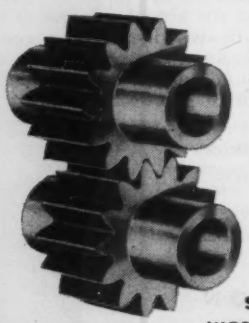
KINNEY MANUFACTURING CO.
3569 WASHINGTON STREET, BOSTON 30, MASS.
New York • Chicago • Cleveland • Philadelphia
Los Angeles • San Francisco

We also manufacture Vacuum Pumps, Liquid Pumps and Bituminous Distributors.

CINCINNATI GEARS

Simplify

Your DESIGN PROBLEMS



Specify Cincinnati Gears, Good Gears Only, and you simplify the problem of fitting gear drives into the crowded spaces allowed on so much of your equipment.

Each Cincinnati Gear is made to meet your particular requirements . . . and to your exact specifications.

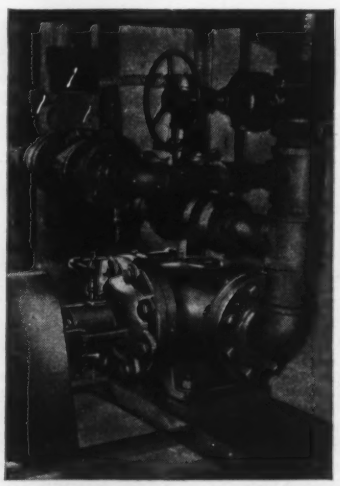
We welcome the opportunity of working with you . . . to simplify your design problems.

SPUR • BEVEL • HELICAL • SPLINE
WORM • SPROCKET • INTERNAL • *ZEROL
*CONIFLEX • SPIRAL BEVEL

*REG. U. S. PAT. OFFICE

THE CINCINNATI GEAR COMPANY
"Gears . . . Good Gears Only"
Wooster Pike and Mariemont Ave. ★ Cincinnati 27, Ohio

Silent elevator service



made possible by IMO OIL PUMP

This quiet, reliable, pulsation-free, vibrationless pump is just the thing for hydraulic elevator operation — or any other service where noise is a nuisance and reliability is essential.

De Laval-IMO pumps are available for general handling of oil and fluids over a wide range of viscosities.

Send for Catalog LE I-152D

IMO means I MOVE OIL

IMO PUMP DIVISION of the
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

INSUROK
by RICHARDSON

Dependable names in plastics

UNDIVIDED RESPONSIBILITY

Many users of plastics enjoy Richardson's VARIETY of products and services. They like the convenience of handing all of their plastics problems to one organization. More important, they like for Richardson to assume complete responsibility for their plastics requirements.

Such an arrangement is possible with Richardson because here, from one company, you can get (1) Laminated INSUROK in a wide variety of grades suitable for virtually every plastic laminate requirement (2) complete punching facilities (3) complete fabricating facilities (4) complete molding facilities (5) experienced engineering (6) complete laboratory facilities if your job calls for laboratory research (7) mold and die design and facilities to produce molds and dies and (8) conscientious, personal attention to your particular needs.

Why not see what this variety of products and services can do for you? Send a set of specifications today and learn, without obligation, how Richardson would approach your job . . . find out for yourself how Richardson's "undivided responsibility" can work to your advantage.

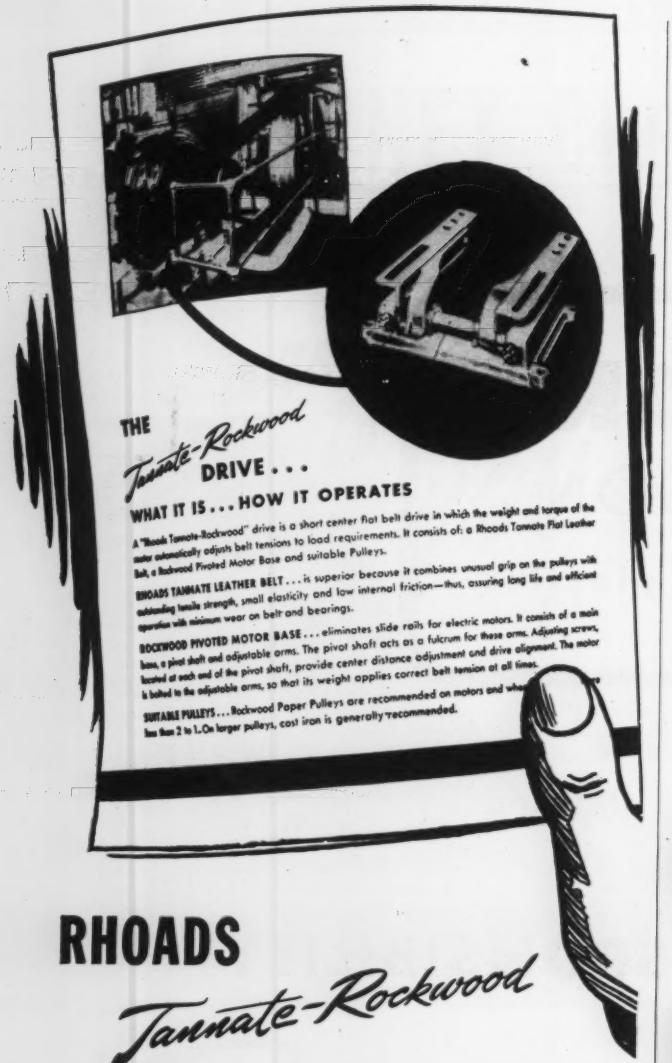
INSUROK is a registered trade-mark of The Richardson Company

The RICHARDSON COMPANY

GENERAL OFFICES: LOCKLAND, OHIO FOUNDED IN 1858

Sales Headquarters: MELROSE PARK, ILLINOIS

CLEVELAND - DETROIT - INDIANAPOLIS - MILWAUKEE - NEW BRUNSWICK, (N. J.) - NEW YORK - PHILADELPHIA - ROCHESTER - ST. LOUIS



RHOADS

Tannate-Rockwood

SHORT CENTER DRIVE

WHAT IT IS . . . HOW IT OPERATES

Before purchasing *any* short center drive, learn more about the efficient TANNATE-Rockwood Drive. Our 16-page, illustrated booklet "tells all" . . . "What" it is . . . "How" it operates . . . and "Where" it can be used.

Send for your FREE copy of this informative booklet —TODAY!

PRODUCERS OF FINE LEATHER FOR 247 YEARS

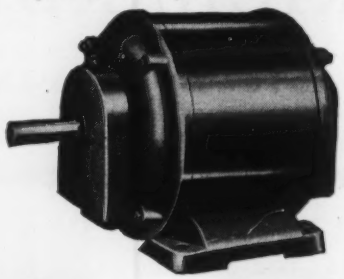
J. E. RHOADS & SONS

35 NORTH SIXTH ST., PHILA. 6, PA.

NEW YORK • CHICAGO • ATLANTA

This MOTOR *comes from a large Family!*

VALLEY Ball Bearing Motors are built in sizes from ½ hp up to 75 hp, providing wide adaptability in power planning. VALLEY'S cool running splash proof, dust proof construction insures long hours of dependable power under the most hazardous conditions.



You'll find the type of Motor you need in your power planning when you investigate VALLEY MOTORS.

Valley

VALLEY

ELECTRIC CORPORATION

4221 FOREST PARK BLVD. • ST. LOUIS 8, MO.

TRACING CLOTH FOR HARD PENCILS

• Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, non-smudging lines.

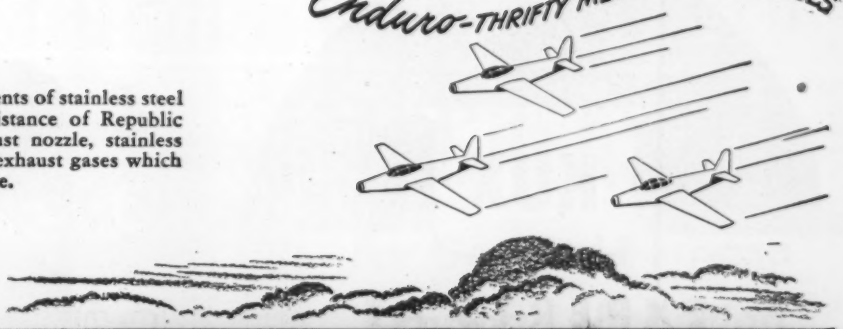
Erasures are made easily, without damage. It gives sharp, contrasting prints of the finest lines. It resists the effects of time and wear, and does not become brittle or opaque.

Imperial Pencil Tracing Cloth is right for ink drawings as well.

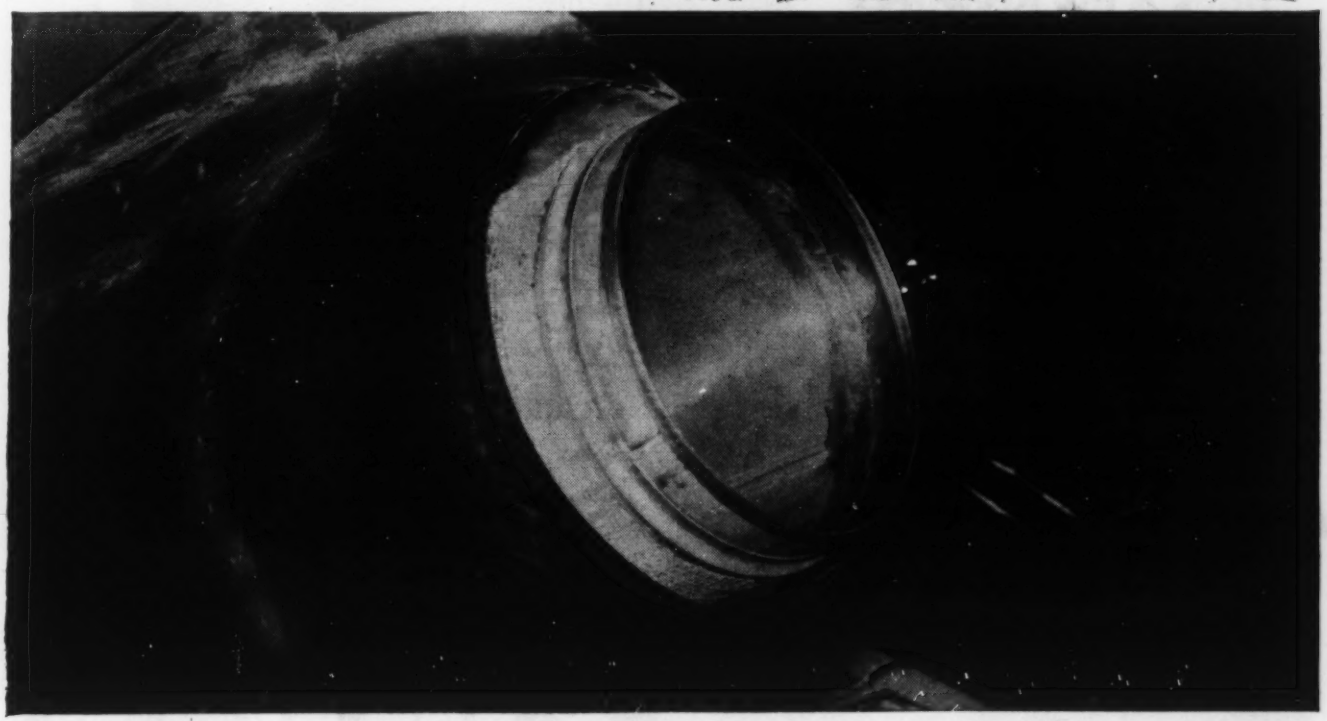
IMPERIAL PENCIL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE

Enduro-THRIFTY METAL OF 10,000 USES



JET ENGINES—with their various components of stainless steel furnish an outstanding example of the heat-resistance of Republic ENDURO. From combustion chambers to exhaust nozzle, stainless steel holds tight rein on the hurricane of searing exhaust gases which otherwise could easily melt the entire plane structure.



AND SPEAKING OF HEAT-RESISTANCE...

The ability of Republic ENDURO Stainless Steel to maintain its exceptionally high strength in the blistering heat of a jet combustion chamber is but one of the many reasons why this versatile metal is being used throughout industry for an ever-increasing number of high temperature applications—from annealing boxes and furnaces to retorts and vapor condensers.

High corrosion-resistance, ability to withstand rough usage and abuse, fatigue-resistance . . . all are important ENDURO advantages. But one of the most important of all is ENDURO'S unusually high strength-to-weight ratio . . . permitting the use of thin, lightweight structural sections . . . efficiency without either excessive bulk or weight.

Whether you are designing a *product of tomorrow* or further improving or refining your present product or products, keep ALL of the advantages of ENDURO Stainless Steel in mind. For additional information or specific technical data, write today to:

REPUBLIC STEEL CORPORATION

Alloy Steel Division • Massillon, Ohio

GENERAL OFFICES • CLEVELAND 1, OHIO

Export Department: Chrysler Building, New York 17, New York

Enduro **STAINLESS STEEL**

REG. U. S. PAT. OFF.

REPUBLIC STEEL

✓ **Check ALL 12 advantages:** • RUST AND CORROSION-RESISTANCE • HEAT-RESISTANCE • HIGH MELTING POINT • LOW COEFFICIENT OF EXPANSION • HIGH STRENGTH • GOOD DIMENSIONAL STABILITY • NO METALLIC CONTAMINATION • EASY TO CLEAN • EASY TO FABRICATE • EYE APPEAL • LONG LIFE • LOW END COST

KUX

EXPERTS AT

CAM

CUTTING and GRINDING

The largest, most completely equipped plant in the country devoted to CAM cutting and grinding is at your service. 25 YEARS of experience in making special cams for thousands of companies has made us experts at cam cutting and grinding. Our facilities and equipment, finest in the country, permit us to manufacture any style or size Cam, Geneva Motion or Scroll Plate in quantities of 1, 10 or 10,000. Accuracy can be maintained to split thousandths, and surfaces to micro-finishes. Send us specifications or blueprints and we will be glad to submit a detailed quotation on your requirements.

KUX MACHINE COMPANY

3930 WEST HARRISON STREET • CHICAGO 24, ILLINOIS

Volume users of *Special Fasteners* and allied devices turn first to

UNITED-CARR

for cost-cutting design engineering service

Send us your specifications or requirements. Address Dept. 11

UNITED-CARR FASTENER CORP.

Cambridge 42, Mass.

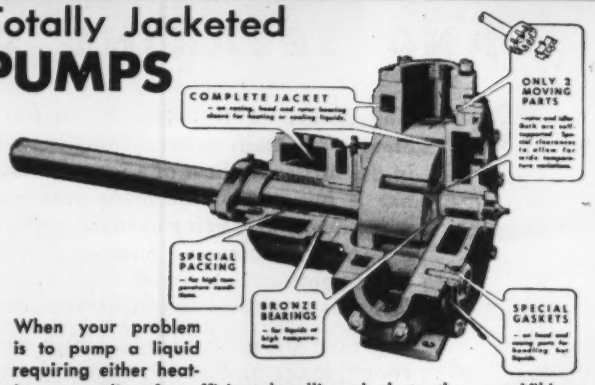
MAKERS OF DOT FASTENERS

A Complete NEW LINE of

VIKING

Totally Jacketed

PUMPS



When your problem is to pump a liquid requiring either heating or cooling for efficient handling, look to the new Viking line of totally jacketed pumps.

Complete jackets surround the pump casing, head and stuffing box. Pump available with any combination of jackets.

Special bearings, packing and gaskets are standard equipment for handling hot liquids. Complete jacketed pumps furnished in 90, 200, 300 and 450 gpm sizes. Jacketed heads available for pumps of lower capacity.

Ask for free bulletin 901H today for complete specifications.

VIKING AN HONORED NAME IN PUMPING

See Our Catalog In SWEETS

Viking PUMP COMPANY

Cedar Falls, Iowa

Announcing "NORMA" Stability-Tested GREASE

For General Purpose Bearing Lubrication

- ***CUTS BEARING LUBRICATION COSTS***
- ***INCREASES BEARING LIFE***
- ***ASSURES EFFICIENT BEARING OPERATION***

Users of ball and roller bearings can now obtain "Norma" Stability-Tested grease for all types of general purpose bearing lubrication.

. Used for years in Norma-Hoffmann prepacked sealed bearings, "Norma" Stability-Tested grease has been giving excellent performance in all types of applications.

Outstanding advantages include —

High Resistance to Oxidation in storage and in service as proven by the well known Norma-Hoffmann Oxidation Bomb Test.

Insoluble in Water — will not emulsify or aerate in the presence of condensed moisture.

Protects Against Corrosion — Actual field tests in the Canal Zone prove its outstanding corrosion resistance.

Laboratory Tested—Each batch of grease is laboratory controlled to meet rigid specifications.

"Norma" Stability-Tested grease is available in tubes for easy bearing lubrication and in bulk for large quantity grease users. Keep your bearings operating at peak efficiency, use "Norma" Stability-Tested grease. Write for prices and information.

RUNNING TESTS FOR GREASE PERFORMANCE

The test units, illustrated, determine the lubricating properties of "Norma" Stability-Tested greases at elevated temperatures and under actual running conditions. Greases are tested in bearings operated at constant speed and temperature with regular cooling and starting cycles. Bearings are thrust loaded by springs. In other test units, bearings are loaded radially.

NORMA-HOFFMANN *Precision* **BEARINGS**

BALL • ROLLER • THRUST

NORMA-HOFFMANN BEARINGS CORPORATION

Stamford, Connecticut

Field Offices: New York • Chicago • Cleveland • Detroit • Cincinnati • Los Angeles • San Francisco • Dallas • Seattle • Phoenix

We don't depend upon our customers to "test out" MECHANICS Roller Bearing UNIVERSAL JOINTS in their products. Long before MECHANICS joints are offered to users, they are subjected to the most gruelling "torture" tests — at excess speeds — to take out friction, wear, vibration, breakage and all other "bugs" that cause ordinary universal joints to fail in service. The wobble, flexure and stress-strain tests are more severe and the fatigue, temperature and wear-resistance tests are conducted many more continuous hours than the joints ever will have to meet in actual use. Let our engineers show you how our grain-structure-to-final-inspection testing of MECHANICS Roller Bearing UNIVERSAL JOINTS will contribute to the smooth, reliable operation of *your* product.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner

2032 Harrison Avenue
Rockford, Illinois

MECHANICS
Roller Bearing
UNIVERSAL JOINTS
For Cars · Trucks · Busses and Industrial Equipment

SPECIFY
alliance motors
for your
FANS

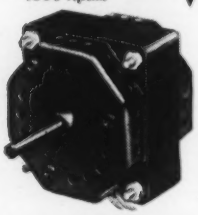
Mass production for mass markets —that's why Alliance is the best source for low cost, small load motors.

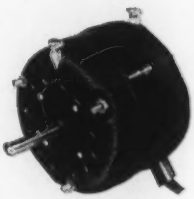
Alliance Motors have these outstanding advantages:

Low operating cost **Cool running**
Low induced hum **Flexible power range**
Low magnetic field **Slower controlled speeds**

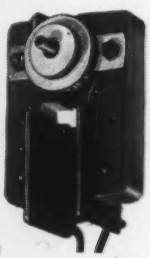
Alliance builds 4-pole and 6-pole shaded pole induction motors with speeds from 500 to 1550 rpm and from 1/100 h.p. up to 1/25th h.p. Smaller 2-pole shaded pole motors will supply as little as 1/400 h.p.

MODEL B
4-pole shaded pole motor. Approx. 1/30 h.p. 1550 r.p.m.





Typical Fan Motor Uses
Air Circulators
Room Heaters
Exhaust Fans
Coolers
Air Conditioners
Unit Heaters
Hair Dryers
Controls



MODEL A
6-pole shaded pole motor. Approx. 1/30 h.p. 500 to 1050 r.p.m.

MODEL MS
2-pole shaded pole motor — full load h.p. .0021. Full load 2800 r.p.m.

Write for catalog and specifications

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO
Export Department: 401 Broadway, New York 13, N. Y., U. S. A.

"HALLOWELL" Solid Steel Collars, functionally proportioned throughout . . . precision-machined so faces run perfectly true . . . are beautifully polished all over . . . yet they cost less than common cast iron collars. 3" bore and smaller are made from Solid Bar Stock. To make sure the collar won't shift on the shaft, they are fitted with the famous "UNBRAKO" Knurled Point Self-Locking Socket Set Screw—the set screw that won't shake loose when once tightened. "HALLOWELL" . . . a "buy word" in shaft collars . . . available in a full range of sizes for

IMMEDIATE DELIVERY

Write for name and address of your nearest "HALLOWELL" and "UNBRAKO" Industrial Distributors.

OVER 46 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

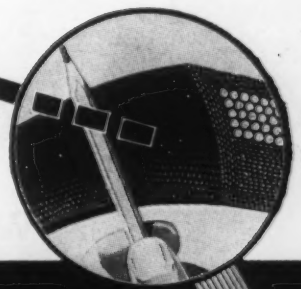
JENKINTOWN, PENNSYLVANIA BOX 102
CHICAGO - DETROIT - ST. LOUIS - SAN FRANCISCO

This Simple Test
Shows Exactly How

The CONCAVE SIDE...

(U.S. Patent No. 1813698)

Saves You Money!



REG. U. S. PAT. OFF.

The Mark of SPECIALIZED Research

Pick up *any* V-belt having the ordinary straight sides and *bend* the belt. Three things will happen, right before your eyes.

(1) The top of the belt is under tension and grows *narrower.* (2) The body, under compression, becomes wider. (3) The sides of the belt *bulge out.* (Figures 1 and 1-A, below.)

Straight-Sided V-Belt

How Straight-Sided V-Belt Bulges in Sheave-Groove

This bulging of the straight-sided V-belt in its sheave-groove costs you money in *two* ways—(1) The bulge causes uneven sidewall wear—*shorter life!* (2) The bulging side cannot evenly grip the wall of the sheave groove—a loss in *transmission efficiency!*

In figures 2 and 2-A, you see how the precisely engineered *concave* side of the Gates Vulco Rope exactly corrects this bulging.

Gates Vulco Rope with Concave Side.

No Side Bulge. Precise Fit in Sheave-Groove.

Two distinct *savings* result. (1) The Gates Vulco Rope wears evenly—*longer life!* (2) The entire side-wall grips the pulley—carries heavier loads and *sudden load increases* without slippage:—saves *belts* and also *saves power!*

The Concave Side is *MORE IMPORTANT NOW* Than Ever Before

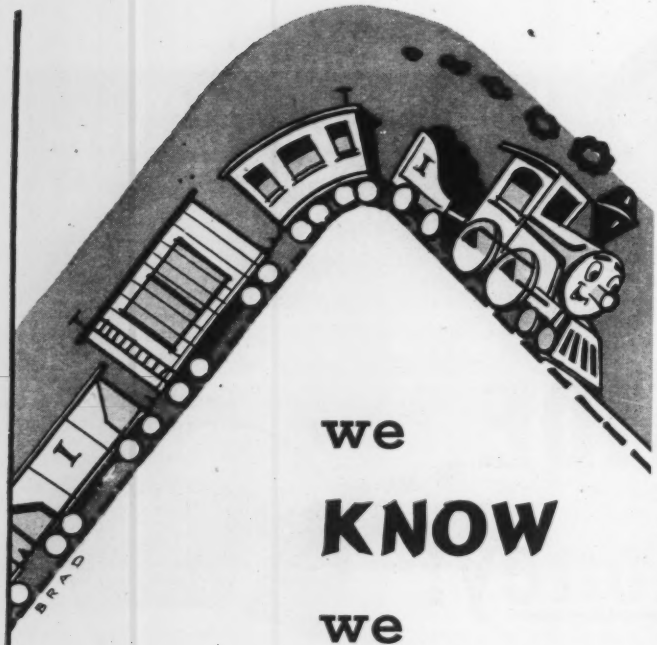
Because the sides of a V-Belt are what actually drive the pulley, it is clear that any increased load on the belt means a heavier load that must be transmitted to the pulley directly through the belt's sidewalls.

Now that Gates *SPECIALIZED* Research has made available to you SUPER Vulco Ropes—carrying fully 40% higher horsepower ratings—the life-prolonging Concave Side is naturally more important in conserving belt life today than ever before.

498

GATES VULCO ROPE DRIVES
IN ALL INDUSTRIAL CENTERS

THE GATES RUBBER COMPANY
DENVER, U.S.A.
The World's Largest Makers of V-Belts



we
KNOW
we
can

We've been getting hard-to-make gears "over the hump" for 43 years.

The driven gear shown here is 5" in pitch diameter and 15" long overall. It is carburized and hardened with heat treating distortion held within .001".

Indiana GEARS

GEARS • CAMS • INTRICATE AND PRECISE MACHINE PARTS

INDIANA GEAR WORKS • INDIANAPOLIS 7, IND.

Miniature
BALL BEARINGS

SOME ACTUAL SIZES

Over 200 types and sizes allow you to select the correct miniature ball bearing for your application, including:

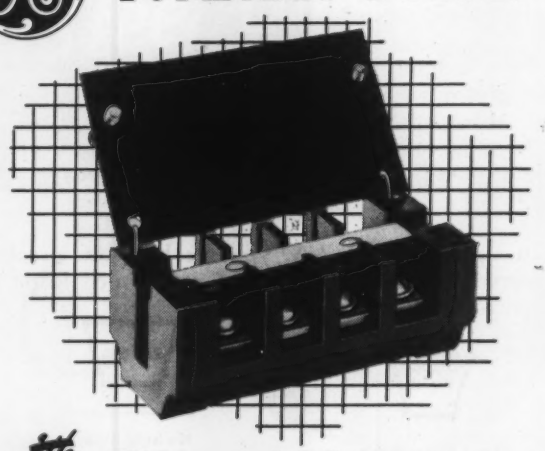
- Smallest pivot ball bearing ever made commercially anywhere (.041" O.D.)
- Smallest fully ground radial bearing (.118" O.D.); uninterrupted raceways, no filling slots or notches; with ball retainers and with or without shields.

RMB

Deliveries prompt and dependable. Ask for your copy of our catalogue and price list. Substantial quantity discounts.

LANDIS & GYR, INC.
104 FIFTH AVE.
NEW YORK 11
N. Y.

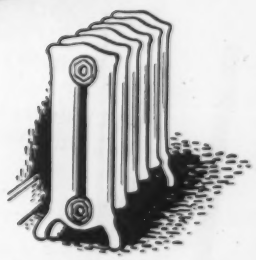
Terminal Boards



with Hinged Covers

Easy-action hinges on these terminal boards . . . and the connectors really grip the wires and make wiring easy. Marking strips are reversible . . . white on one side, black on the other. Available 4 to 12 poles, 2 inches wide, 1¼ inches high. See your nearest G-E sales representative about these terminal boards. Write for Bulletin GEA-1497. *Apparatus Department, General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC



Durability...

is synonymous with Gray Iron

"A picture is worth a thousand words." Look at this picture of Hiroshima. See the radiators? They're *Gray Iron.* That's part of what we mean by Durability, defined by Webster as: . . . "enduring".

Throughout the year, we have discussed and illustrated the resistance of Gray Iron to wear, heat and corrosion. These characteristics all contribute to Durability, but they're not the whole story.

Gray Irons are available in a wide range of analyses. They provide combinations of valuable properties unmatched by any other material . . . plus ultimate economy.

Write for free booklet, "GRAY IRON—Its Mechanical and Engineering Characteristics and Details for Designing Cast Components".

Make It Better With Gray Iron

Second largest industry in the metalworking field

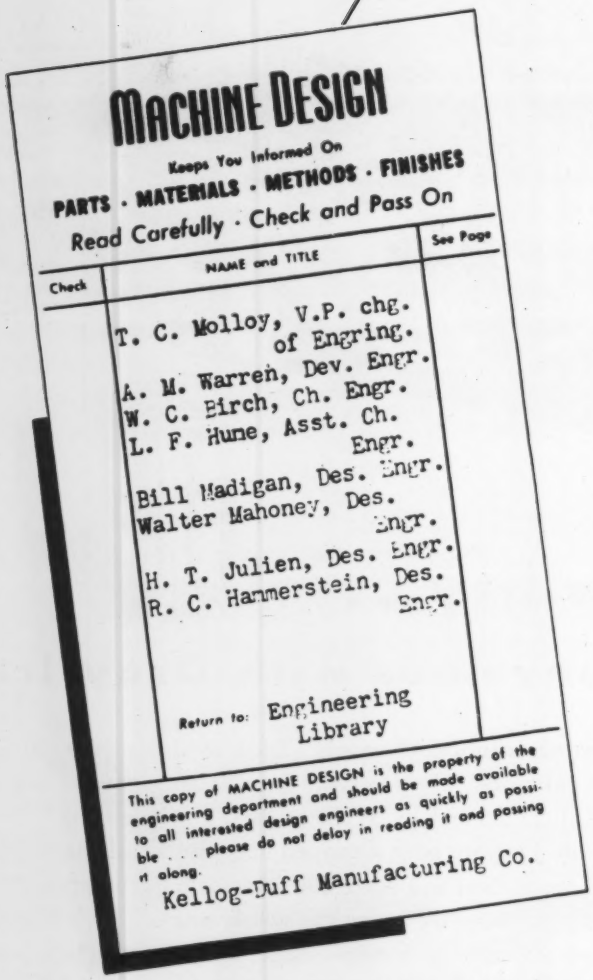
Gray Iron Characteristics Include:

- Castability
- Rigidity
- Low Notch Sensitivity
- Wear Resistance
- Heat Resistance
- Corrosion Resistance
- Machinability
- Vibration Absorption
- DURABILITY
- Wide Strength Range

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

ROUTING SLIPS...



make MACHINE DESIGN *available to additional Design Engineers...*

- Hundreds of engineering departments are using routing slips to make MACHINE DESIGN systematically available to their design engineers.

These convenient slips are gummed on the back so that they can readily be affixed to the front cover of MACHINE DESIGN when it arrives each month.

If you would like a free supply, fill in the names and titles of your readers in order of routing on the coupon below. We will prepare them and send them to you promptly.

FREE

SIMPLY FILL IN THIS BLANK TO GET YOUR SUPPLY

MACHINE DESIGN, Readers' Service Dept., Penton Building, Cleveland 13, Ohio

Please send a supply of routing slips (free of charge) imprinted as follows:

1. _____ Name and Title
2. _____ Name and Title
3. _____ Name and Title
4. _____ Name and Title
5. _____ Name and Title
6. _____ Name and Title
7. _____ Name and Title
8. _____ Name and Title

Return to: _____

COMPANY NAME ..... ADDRESS .....

CITY ..... ZONE ..... STATE .....

YOUR NAME ..... YOUR TITLE .....

Precision for delicate instruments... Ruggedness for jet aircraft engines—

CMH Steel Stainless Bellows

CMH manufactures the complete line of "proved-in-service" stainless steel bellows ***in sizes from ½" through 10".*** Extensive experience in the manufacture of these units for an extremely broad range of applications has resulted in ***standardized production*** techniques.

This means better performance and greater dependability for use in your product, hence economy.

Ask for complete information on how CMH Stainless Steel Bellows can be used in the product you make.

Bellows data sheets are available on request. Write for a set and have this material available for reference at all times.

CMH
STAINLESS STEEL BELLOWS
offer these 7 important advantages!

1. Corrosion resistance
2. High and low temperature
3. High strength
4. Uni-metal fitting assembly
5. Multiple ply construction (when required)
6. Long lengths
7. Complete size range—½" through 10"

CMH—ONE dependable source
for every flexible metal hose requirement

• CMH manufactures all standard types of flexible metal hose, both convoluted and corrugated, in a variety of metals; expansion joints for piping systems; stainless steel and brass bellows; various conduits and special assemblies of these components.

CHICAGO METAL HOSE CORPORATION

CMH

Leaders in the Science of Flexonics
MAYWOOD, ILLINOIS
Plants at Maywood, Elgin and Rock Falls, Illinois
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ontario
FLEXON . . . . . identifies CMH products which have served industry for more than 47 years.

high ratios ?

ONE OF 93

DE LAVAL
DOUBLE REDUCTION WORM GEARS

De Laval double reduction speed reducers, consisting of combinations of double worm gear reductions, or helical and worm gear reductions, are available with overall ratios up to approximately 8000 to 1. De Laval single reduction worm gear speed reducers are available in ratios up to 90 to 1. If high ratios are your requirement, worm gear speed reducers are the answer—particularly if space is limited and reliability is important. A De Laval representative will help you pick the right size and type.

This double reduction De Laval Worm Gear Speed Reducer is available in many standard ratio combinations, with horizontal or vertical output shafts and is but one of 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

WG-14

DE LAVAL

Worm Gear Division: De Laval Steam Turbine Co., Trenton 2, N.J.

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS
CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

Just Try

1

MOCCASIN BUSHING...

ON YOUR MOST TROUBLESOME BEARING

and be convinced

The success of Moccasin Bushings' efficiency lies in their unique lubrication principle. Oil is drawn from a reservoir in the bearing housing and is distributed by capillary action in a continuous, unbroken film over the entire bearing surface. Drippage and seepage of oil is entirely eliminated, and under ordinary circumstances they require attention only two to four times a year—just try one on your most troublesome bearing. Guaranteed for satisfactory service. Write for folder No. 428 showing nine other styles of bushings.

MOCCASIN BUSHING COMPANY
Chattanooga · Tennessee

"COMMERCIAL"
BASIC PARTS
FOR
Air Conditioning and Heating
EQUIPMENT

FAN HOUSINGS
OIL BURNER TANK HEADS
OIL BURNER TANK SUPPORT LUGS
HOT AIR FURNACE HEADS
HOT AIR HAT PIPES
HOT AIR CRESCENT HEADS
WATER HEATER TOPS
WATER HEATER LEGS
RANGE BOILER HEADS AND BOTTOMS
TANK HEADS

Write for Literature

THE COMMERCIAL SHEARING AND STAMPING COMPANY.
YOUNGSTOWN · 1 · OHIO · U.S.A.

Write for this specification sheet today. It is a quick, simple means of giving EMC engineers facts about your product, which can be fitted with a custom designed EMC Motor if its power requirements come within the range of 1/2000 h.p. up to 1/2 h.p. No obligation.

TRADEMARK EMC REGISTERED

ELECTRIC MOTOR CORPORATION
Division Howard Industries, Inc.
RACINE • WISCONSIN

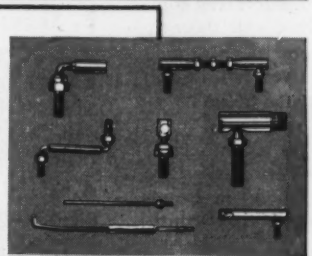
CUSTOM-BUILT FRACTIONAL H.P. MOTORS FOR ALL INDUSTRY

TOUREK BALL JOINTS and SCREW MACHINE PRODUCTS

1 BALL JOINTS

The use of Tourek Ball Joints has helped many manufacturers to improve product performance, simplify design and reduce costs. These benefits are yours too when you specify Tourek!.

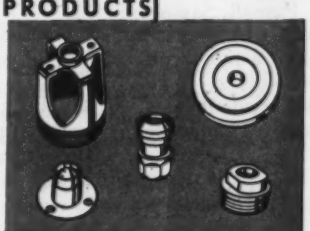
Whether your specifications call for standard or special Ball Joints, you can depend upon Tourek performance, delivery and prices!



Send for your copy of Tourek's 16-page Ball Joint Catalog. It fully describes 12 standard types in 84 sizes (carried in stock), and has data on special types as well.

2 SCREW MACHINE PRODUCTS

Tourek's modern plant—from the tool room to the batteries of giant 6-spindle automatics—is geared to turn out your screw machine product needs in any size up to 2⅜", from any type of metal. Twenty-eight years of production experience back up every job which Tourek undertakes.



For prompt quotation on your screw machine products requirements, simply send blueprint or sample.

MAKERS OF QUALITY SCREW MACHINE PRODUCTS

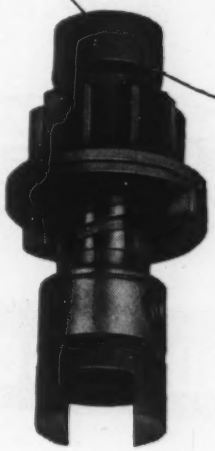
J. J. TOUREK MFG. CO.
4701 W. 16th St., Chicago 50, Ill.

ESTABLISHED 1920
TOUREK
FAMOUS BALL JOINTS

---

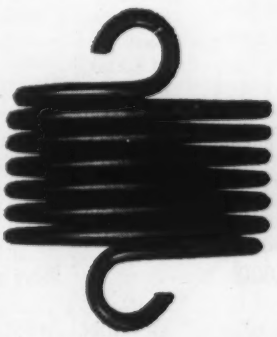
write **Bendix**

FOR BETTER, EASIER, MORE ECONOMICAL TRANSFER OF TORQUE



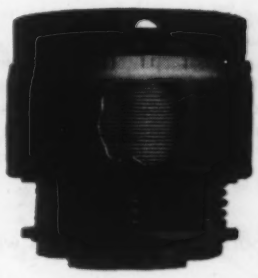
Power Transmittal

Screw Shaft and Pinion—rotation of screw threads moves the pinion backward and forward, allowing the screw shaft to connect and disconnect quickly and easily from a larger gear. Independent coupling on the end for making connections. Available in both right-hand and left-hand types. Useful on reciprocal and oscillating machinery.



Shock Absorption

Torsion Spring—available in different sizes, and in both right-hand and left-hand types, up to 100 ft. lbs. A simple and inexpensive safeguard for valuable machinery.

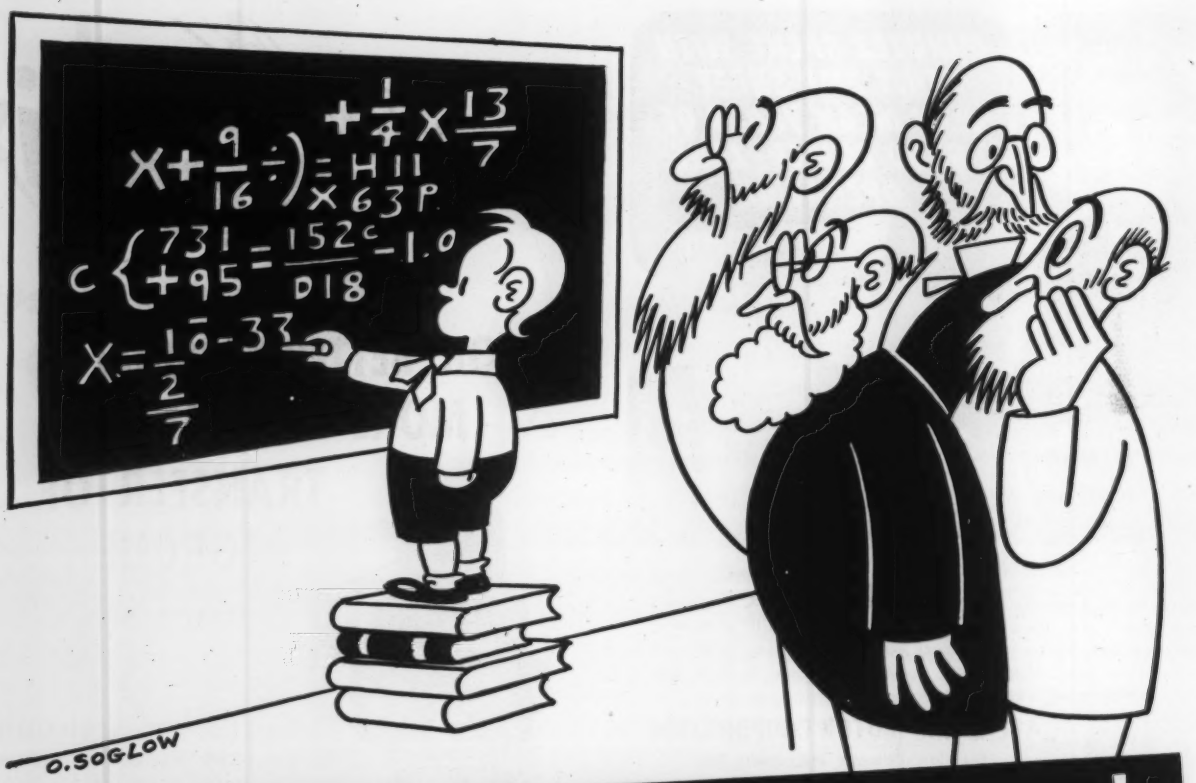


Overload Protection

Multiple Disc Friction Clutch Pack—spring-loaded to slip at a predetermined torque; adjustable from 50 ft. lbs. to 350 ft. lbs. Assures long-life protection wherever torsional loads exist or sudden overloads may damage expensive moving machinery, such as conveyor lines, belts, etc.

OUR ENGINEERS ARE AT YOUR DISPOSAL
For Further Information, Write Direct to

ECLIPSE MACHINE DIVISION OF Bendix AVIATION CORPORATION
ELMIRA, NEW YORK



You'll be surprised at these figures!

- 80 million Americans own $48 billion of U. S. Savings Bonds.
- 20,000 of the nation's 38,000 firms employing 100 or more persons are operating Payroll Savings Plans.
- 7,500,000 workers are buying an individual average of $20 of Bonds per month.
- For the year 1948, sales of Series E Bonds *exceeded redemptions* by $495,148,000. The net figure for all Series after redemptions and maturities was $2,151,140,000.

What does all this mean to you? Well, it means first of all that your Treasury Department is successful in its program of increasing the nation's economic security by spreading the national debt. Secondly it means that most of the nation's business leaders recognize the value of the Payroll Savings Plan sufficiently to promote it within their companies.

For example...

To give you some idea of the Plan's growing popularity: 86,384 employees of a prominent electrical manufacturing company were investing in Bonds at the rate of $30,005,270 as of the end of 1948. This is a gain of nearly 100% over 1947, when 45,000 employees participated in that company. The treasurer of a well-known shoe company reported that, of his concern's 19,060 employees, 9,240 were in the Plan and had invested $146,807.32 in Bonds via deductions during the preceding month.

Why promote it?

We all know how buying Bonds builds an individual's future security. But there are *company* benefits too! Nation-wide experience shows that Payroll Savings increases each participating employee's peace of mind—makes him a more contented, more productive worker. It reduces absenteeism, lowers accident rates, increases output, and improves employee-employer relations.

It's easy to boost participation

1. See that a top management man sponsors the Plan.

2. Secure the help of the employee organizations in promoting it.

3. Adequately use posters and leaflets and run stories and editorials in company publications to inform employees of the Plan's benefits to them.

4. Make a person-to-person canvass, once a year, to sign up participants.

These first four steps should win you 40-60% participation. Normal employee turnover necessitates one more step:

5. Urge each new employee, at the time he is hired, to sign up.

Nation-wide experience indicates that 50% of your employees can be persuaded to join—without high-pressure selling. All the help you need is available from your State Director, U. S. Treasury Department, Savings Bond Division.

The Treasury Department acknowledges with appreciation the publication of this message by

MACHINE DESIGN

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and The Advertising Council.

New

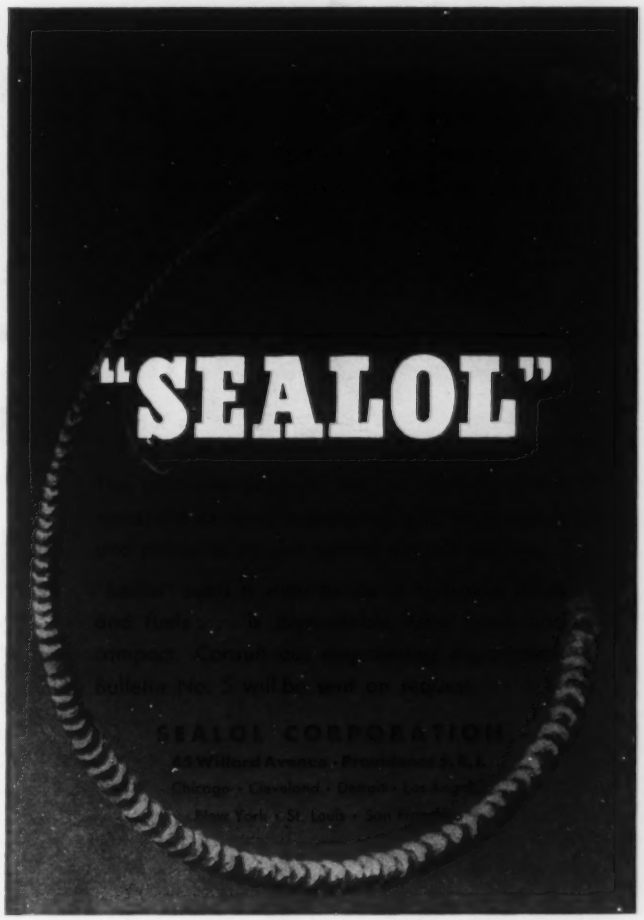
BROWNING FHP BELT

FOR SMOOTH
VIBRATIONLESS POWER

★ NEW DESIGN
★ NEW PERFORMANCE
★ LONG LIFE

WRITE FOR CATALOG V-147

BROWNING MANUFACTURING COMPANY
INCORPORATED
MAYSVILLE, KENTUCKY, U. S. A.



WITH THIS
WISCONSIN HEAVY-DUTY Air-Cooled Engine Powered Welder

Whether in the field or inside the shop, the steady power of the Wisconsin air-cooled engine makes the P & H 200 Amp. NEMA-rated DC Arc Welder a reliable operating tool.

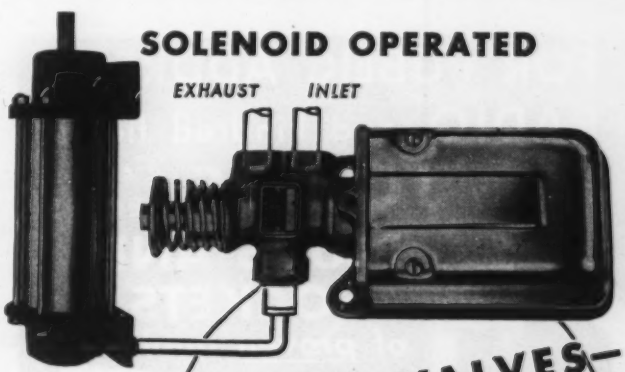
Regardless of the kind of power equipment you make, if a power unit within the 2 to 30 hp. range is indicated, your good name will be amply protected when you specify "Wisconsin Heavy-Duty Air-Cooled Engines". These engines "pay off" with users, in any climate, under the most rugged and adverse operating conditions. Heavy-duty design and construction details such as tapered roller bearings at BOTH ends of the husky crankshaft; rotary type high tension outside magneto with impulse coupling for quick, sure starting; pump lubrication with individual oil stream to each rod; a carburetor that functions at all operating angles . . . these are among the features that assure "Most H. P. Hours" of on-the-job service.

4-cycle single, 2- and 4-cylinder models, 2 to 30 hp.

MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines

SOLENOID OPERATED



AIR CONTROL VALVES—
"VALVAIRS"

- NON-CORROSIVE
- NO METAL SEATS
- FULL PIPE AREA USED

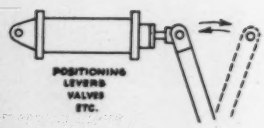
2-WAY
3-WAY
4-WAY
60 numbers to choose from

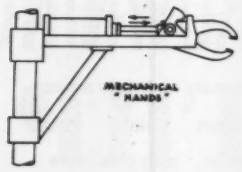
Ask for Folder "S-D".

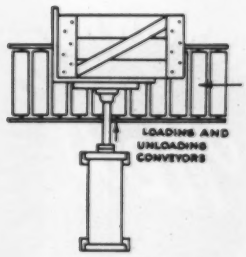
VALVAIR CORPORATION • 454 Morgan Avenue, Akron 11, Ohio
AFFILIATE: SINCLAIR-COLLINS VALVE CO.

Rely Upon Valvair

Here's how to
- CUT COSTS!
- SAVE TIME!
- IMPROVE PLANT OPERATION!







Send for a copy of this Bulletin

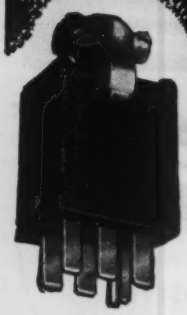
HANNIFIN CORPORATION
1115 South Kilbourn Ave.
Chicago 24, Illinois

Let HANNIFIN Pneumatic Cylinders *do the work!*

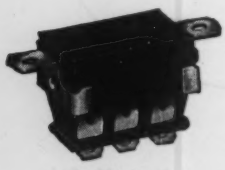
"AUTOMATION" is an interest-rousing new term that describes some of the many ways in which pneumatic cylinders are being used to actuate and power automatic work-saving devices. Hannifin is playing an important part in this development by supplying cylinders that are *right for the job* and engineering *know-how* second to none when it comes to applying cylinders to the job.

If you are interested in using cylinders to SAVE TIME . . . REDUCE PHYSICAL EFFORT . . . CUT COSTS . . . and IMPROVE PLANT OPERATION, get in touch with HANNIFIN today. Engineering recommendations on request. Experienced Factory-trained field representatives in all leading industrial centers.

FOR PUBLIC ADDRESS, RADIO, and kindred fields, specify JONES 400 SERIES PLUGS AND SOCKETS of proven quality!



P-406-CCT



S-406-AB

Double Contact Area

Phosphor bronze knife-switch socket contacts engage both sides of flat plug contacts.

Socket contacts phosphor bronze, cadmium plated. Plug contacts hard brass, cadmium plated. Insulation molded bakelite. Plugs and sockets polarized. Steel caps with baked crackle enamel. 2, 4, 6, 8, 10, 12 contacts. Cap or panel mounting.

Information on complete line, in Jones Catalog 17: Electrical Connecting Devices, Plugs, Sockets, Terminal Strips. Write

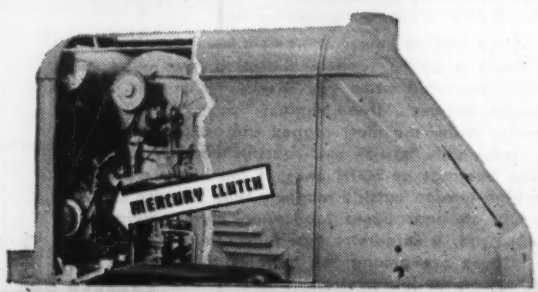
HOWARD B. JONES DIVISION
Cinch Mfg. Corp.
2460 W. GEORGE ST. CHICAGO 18, ILL.

MERCURY CLUTCHES SAVE TIME FOR LITTLEFORD BROS., INC.

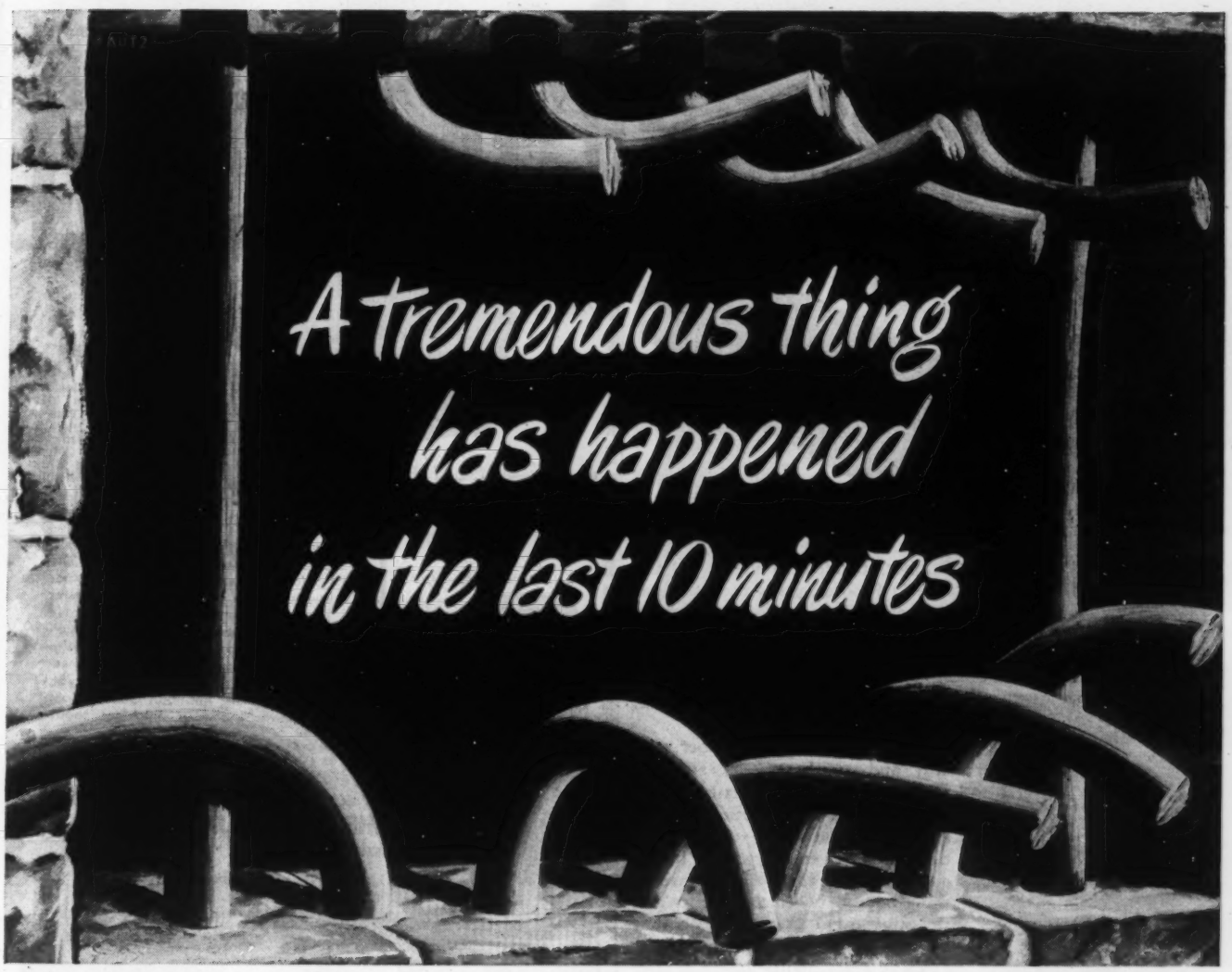
The Wisconsin AK gasoline engine driving the Tankar Heater made by Littleford Bros. Inc. of Cincinnati is equipped with a MERCURY Automatic Clutch to insure load-free starting and idling . . . elimination of engine stalling and time lost on tank car unloading operations.

Like hundreds of leading equipment manufacturers using gasoline engines and electric motors, Littleford know that MERCURY Clutches improve the performance of their equipment and give them a valuable selling argument.

For all original equipment . . . and for gasoline engines and electric motors in your own plant . . . investigate the advantages of MERCURY Automatic Clutches. *Write for full details.*



Mercury Clutch Division
AUTOMATIC STEEL PRODUCTS, INC.
CANTON 6, OHIO



They say dictatorships are new and revolutionary... Actually, they're as old as time itself!

For thousands of years, most of the human beings who have peopled the earth have lived as the slaves or subjects of someone else.

The thing that is new and revolutionary and yours, is *freedom.*

Freedom to choose your job and to bargain collectively, knowing that in America there's no ceiling on advancement.

Freedom to invent new machines . . . and new ways to make them productive . . .

Freedom to invest money in new ideas . . . to *own* things . . . to manage our own affairs.

Freedom to mass-produce more and better goods all the time . . . with lower costs reflected in consumer prices and higher real wages.

Compared to the record of all civilization, this free way of yours is ten minutes old!

Yet in ten short minutes it's done *more good for more people* than anything that ever happened on earth.

In war, it enabled you in America to outproduce the rest of the world combined.

In peace, it's given us a standard of living ten times higher than that of the nation which shouts loudest that we have a dying economy.

Dying? We've just begun to live! We've just escaped from prison. If the way we live is ten times richer than theirs, that's not enough.

We can make it better still. We can eliminate the faults which remain. We can level off the sharp ups and downs of prices and jobs. We can make the final attack against poverty.

Today, the world is depending on us because we have depended on *ourselves.* Let's show others how that system works!

We can—if we'll work together and build together as Americans always have.

Let's keep on building. Build for Freedom . . . build for peace . . . build for a better world!

THE BETTER WE PRODUCE
THE BETTER WE LIVE

Approved for the PUBLIC POLICY COMMITTEE of the Advertising Council by representatives of Management, Labor and the Public:

EVANS CLARK, Executive Director, Twentieth Century Fund.

PAUL G. HOFFMAN, Formerly President, Studebaker Corporation.

BORIS SHISHKIN, Economist, American Federation of Labor.

Published in the Public Interest by:

MACHINE DESIGN

FREE

Send for this valuable booklet today!

In words and pictures, it tells you

—How our U. S. Economic System started
—Why Americans enjoy the world's highest standard of living
—Why we take progress for granted
—How we have been able to raise wages and shorten working hours
—Why more Americans have jobs than ever before
—Why the mainspring of our system is productivity
—How a better living can be had for all

MAIL THE COUPON to Public Policy Committee, The Advertising Council, Inc., 25 West 45th Street, New York 19, N. Y.

NAME_____

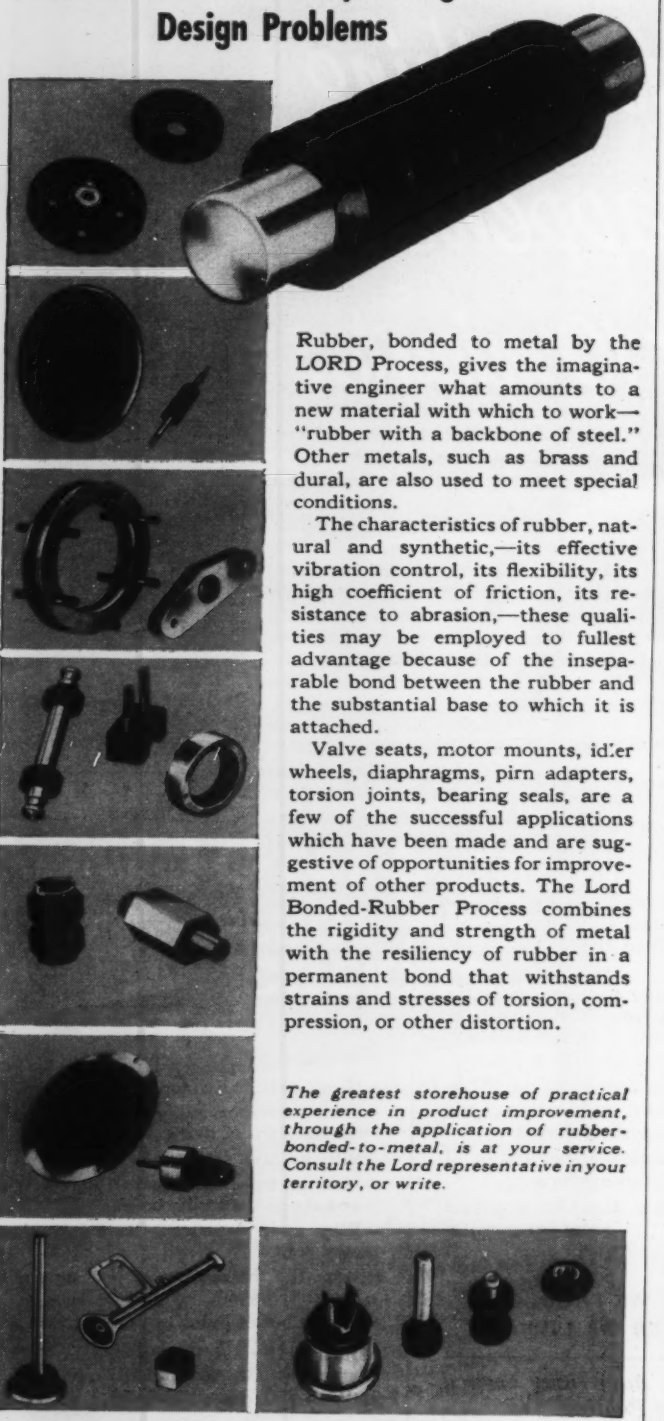
ADDRESS_____

_____

OCCUPATION_____

RUBBER . . . with a backbone of STEEL

LORD BONDED-RUBBER Products Solve Some of Industry's Toughest Design Problems



Rubber, bonded to metal by the LORD Process, gives the imaginative engineer what amounts to a new material with which to work—"rubber with a backbone of steel." Other metals, such as brass and dural, are also used to meet special conditions.

The characteristics of rubber, natural and synthetic,—its effective vibration control, its flexibility, its high coefficient of friction, its resistance to abrasion,—these qualities may be employed to fullest advantage because of the inseparable bond between the rubber and the substantial base to which it is attached.

Valve seats, motor mounts, idler wheels, diaphragms, pirn adapters, torsion joints, bearing seals, are a few of the successful applications which have been made and are suggestive of opportunities for improvement of other products. The Lord Bonded-Rubber Process combines the rigidity and strength of metal with the resiliency of rubber in a permanent bond that withstands strains and stresses of torsion, compression, or other distortion.

The greatest storehouse of practical experience in product improvement, through the application of rubber-bonded-to-metal, is at your service. Consult the Lord representative in your territory, or write.

LORD MANUFACTURING COMPANY, ERIE, PA.

Canadian Representative: Railway & Power Engineering Corp. Ltd.

LORD Vibration Control Systems

✓BETTER DESIGN
✓BETTER WORKMANSHIP
✓BETTER PERFORMANCE
= **RUTHMAN GUSHER COOLANT PUMPS**

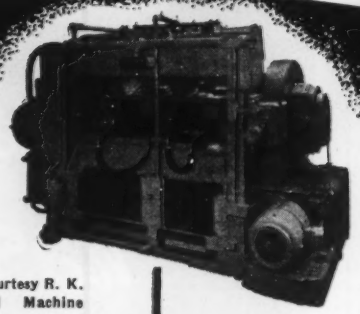
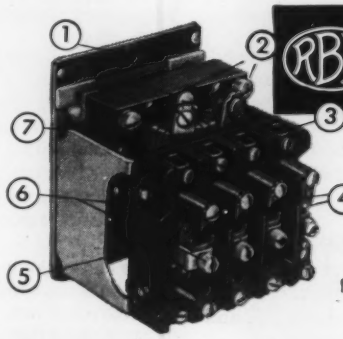


Photo Courtesy R. K. LeBlond Machine Tool Co.

Illustrated is a LeBlond 4 Station Indexing Drum Machine for Turning Automotive Crankshafts, equipped with a ½ H.P. Model 11023-B Long Ruthman Gusher Pump.

Expertly designed and precision built of the best materials, Ruthman Gusher Coolant Pumps give you top performance on your coolant systems. Their wide acceptance as the leaders in the coolant pump field is your best assurance that Ruthman Gusher Coolant Pumps are the best you can buy. If you want more for your money, specify Ruthman Gusher Coolant pumps on your machines today.

THE RUTHMAN MACHINERY CO.
1811 Reading Road Cincinnati, Ohio



RBM INDUSTRIAL CONTACTORS

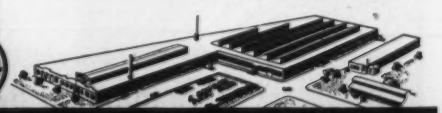
2 TO 8 POLE
600 VOLT A. C.
10—15 AMPERE SIZES
REVERSING—NON-REVERSING TYPES
INTERCHANGEABLE CONTACTS

1. Heavy steel base.
2. Coil readily replaced by removing 2 heavy screws holding E-shaped magnet frame.
3. Accessible solderless type terminals are conveniently located. All line terminals at top; load terminals at bottom.
4. Any pole can be changed from normally open to normally closed, or vice-versa, without additional parts.
5. Melamine stationary contact block and movable contact carrier.
6. Stationary and movable contacts can be readily replaced with use of screw driver only and without removing wiring.
7. Vacuum impregnated magnet coil designed for continuous 50/60 cycle service.

For descriptive bulletin No. 600 write Dept. H-7

R-B-M DIV., ESSEX WIRE CORP.
LOGANSPORT, INDIANA

RBM



MANUAL AND MAGNETIC ELECTRIC CONTROLS
—FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

Standard WASHERS

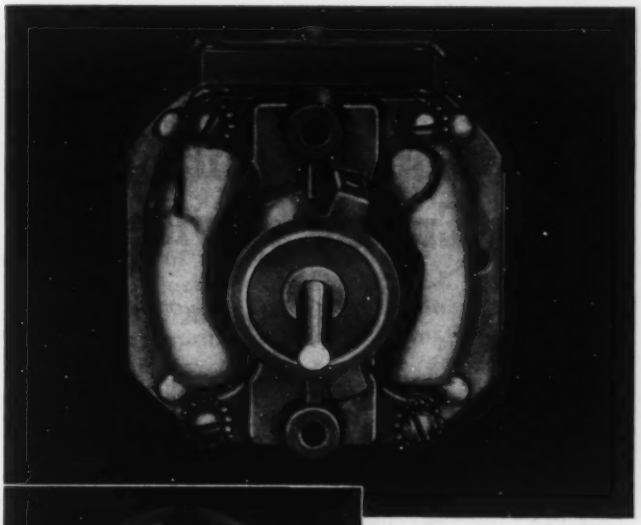
PRESS ON . . .
quick, positive assembly.

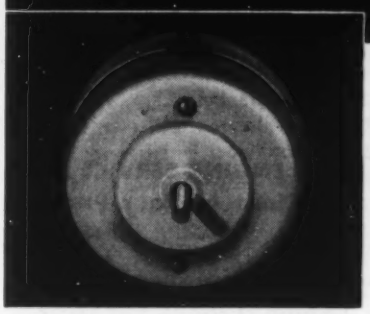
CLAMP SHUT . . .
360° closure supports greater thrust loads.

OPEN . . . PULL OFF . . .
fast, easy removal simplifies service and repair.

Available for pin diameters—
7/32" to 17/32".
Write for Bulletin 26.

Standard
LOCKNUT & LOCKWASHER, INC.
118 W. ST. CLAIR ST., INDIANAPOLIS 4, INDIANA





Skeleton view of our improved 4-pole Shaded Pole Motor showing the New 4-Point Bearing Bracket.

Same Motor Enclosed.

A NEW DEVELOPMENT

IN 4-POLE SHADED POLE MOTORS
OUR IMPROVED 4-POINT BEARING BRACKET

SKELETON OR ENCLOSED TYPE AS SHOWN
120 v. A.C. — 60 Cy. Approx. 1700 R. P. M.

Our new and improved 4-point bearing bracket makes our 4-pole shaded pole motor outstanding. Compare this motor with *any* other and see for yourself.

- **Absolutely uniform air gap of minimum width.**
- **Permanent rotor position within stator.**
- **Housing entirely separate.**
- **Priced competitively.**

Write, wire or phone for sample telling us your requirements—Memorandum invoice. The Loyd Scruggs Co., 1022-32 N. Sixth St., St. Louis 1, Mo., Telephone: CHestnut 2668.

NOW IN USE ON

Air Circulators
Wire Recorders
Air Conditioners
Business Machines
Fans and Blowers
Vending Machines
Ventilating Fans
Oil Circulating Heaters
Exhaust Fans
Floor Heaters
Unit Coolers
Refrigerator Condenser Fans
Coolant Pumps
Floor Air Circulators
Unit Heaters
and many others.

THE Loyd Scruggs COMPANY
MANUFACTURERS OF PRECISION INSTRUMENTS

Acme Offers
Complete Facilities for
PRECISION GRINDING
FAST SERVICE . . . LOW COST

- INTERNAL
- EXTERNAL
- CRUSH FORM
- CENTERLESS
- TWIN DISC
- SURFACE
- THREAD

Acme is equipped to handle all types of precision grinding. Expert craftsmen, using newest methods and modern equipment, will do the job for you faster, better, more economically. Acme also offers a flat lapping service that can finish surfaces to within millionths. Write for details.

Acme Industrial Company
Makers of Standardized Jig & Fixture Bushings
211 N. LAFLIN STREET • CHICAGO 7, ILLINOIS
THE SERVICE SHOP TO INDUSTRY FOR MORE THAN 25 YEARS

ALLIS-CHALMERS'
Country-Wide Engine Service

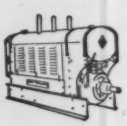
CAN HELP CLINCH SALES of your Products

A-C ENGINE SERVICE . . . As Close As Your Phone

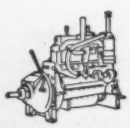
There's service nearby for every Allis-Chalmers Engine through the thousands of authorized A-C dealers . . . your assurance of prompt service and genuine parts that build greater acceptance for your products.

Designed for tough tractor service, these heavy-duty engines build customer satisfaction through performance, too. They are high in torque, hang onto overloads. Users also like the low first cost — due to mass production — as well as the economical operation and low upkeep.

Investigate these prestige-building, dependable Allis-Chalmers Power Units for your own products. Our engineers will gladly work with you in selecting the unit for your requirements.



A MODEL TO FIT Your Needs



MODEL*	R.P.M.	MAXIMUM BRAKE HP.
B-125	1500-1800	24.5-28.0
W-201	1400-1800	33.5-40.5
U-318	1200-1400	45.0-50.9
E-563	1050	74.0
L-844	1050	110.0

*Figures represent cu. in. piston displacement.

Accessories to fit applications. Choice of fuels.

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

ENGINEERS AVAILABLE OR WANTED

WANTED: Designing engineer. Nationally known manufacturer of mining equipment has opening for a designing engineer. Must have a thorough knowledge of operation and construction of all types of rock drill equipment. Address Box 648, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

♦ ♦ ♦

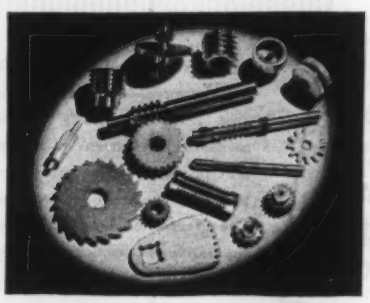
WANTED: Project engineer for development of a new type automatic milling machine. Experience and imagination will be required to solve the unusual electrical and electronical problems, as well as the machine design problems involved. Prior to arranging personal interview, please forward resume of your experience to Box 649, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

♦ ♦ ♦

WANTED: Contact sales engineer. Preferably 30-40 years old, college graduate, to contact foundry superintendents and purchasing agents—an overall technical factory representative with metallurgical experience. An exceptional opportunity with an old time company, leader in its field. State experience, references and salary received now. Address Box 650, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

why Abart GEARS ? specialization is the answer

Yes, experienced specialization on producing not the most gears, but *better* gears. . . . accurate, dependable, uniform . . . cut exactly to your particular specifications. Whether your order is for a few hundred or many thousands . . . standard or special . . . Abart's modern, highly developed production methods will give a degree of craftsmanship which is unsurpassed . . yet the cost will be very moderate. NO STOCKS. Put your gear problem in the hands of specialists—*Put It To Abart.*



SPUR
WORM
BEVEL
WORM WHEELS
HELICAL
& SPIRAL
SPROCKETS

Send B/P, Sample or Specifications for Prompt Quotation—No Obligation, of Course.

Abart GEAR & MACHINE CO.
4821 W. 16th St., Chicago 50, Ill.

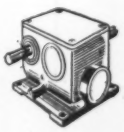
Ask for 24-page catalog "M-7", containing technical data on Euclid Speed Reducers.

INVESTIGATE THE ADVANTAGES of..

Euclid Universals

.... IT COSTS NO MORE TO GET

ALL THE ADVANTAGES OF *Euclid Universal* DESIGN!



Double reduction gear unit.

Whether in standard or special design, Euclid Universal Speed Reducers offer unique, proven advantages: (1) removable base plate making possible various shaft positions; (2) gears with 20° pressure angle, increasing torque and horse-power capacity; (3) streamlined design, eliminating protruding bolts and stubs; (4) all shafts Timken mounted to withstand load; (5) oversize shafts for special applications.

Write on your letterhead for valuable catalog.

SUCCESSOR TO EUCLID MACHINE & TOOL COMPANY

EUM EUCLID UNIVERSAL MACHINE, Inc.

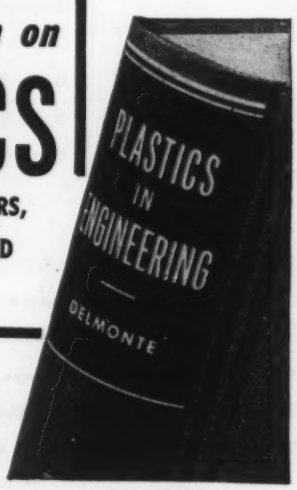
15002 WOODWORTH ROAD • CLEVELAND 10, OHIO

3-WAY UNIVERSAL SPEED REDUCERS

NEW Information on

PLASTICS

FOR DESIGNERS, FABRICATORS, AND EVERYONE INTERESTED IN PLASTICS . . .



• Here's important new information on plastics for every designer, every fabricator, user and student of plastics . . . 656 pages . . . 168 illustrations . . . of authoritative plastics information. This complete, revised, third edition of "Plastics in Engineering" by John Delmonte will alert you to the wide possibilities offered by plastics in your field. It tells you all about the many different plastics available: How strong they are—for what uses they are best suited—how to design plastic parts—how they are molded, extruded, laminated, cast—how much heat they will stand—how to guard against failures—how to machine plastics—and other vital factors that are so essential to satisfactory plastics performance.

THIRD EDITION

Completely Revised

$10.00 *POSTPAID**

The Penton Publishing Co., Book Dept., 1219 W. 3rd. St., Cleveland 13, O.
Enclosed is $10.00* for my copy of "Plastics in Engineering".

Name

Address

City State

*Ohio orders must add 30c additional to cover state sales tax.

Are You Interested In Reducing Spring Failures?

Hundreds of design engineers have discovered "Mechanical Springs" by A. M. Wahl to be an important aid in helping them to solve their spring design problems. Based on original research and practical applications, "Mechanical Springs" has long been recognized as the outstanding work in its field.

"Mechanical Springs" is filled with the kind of information that will enable preliminary calculations to be made on the design of all types of springs: compression . . . tension . . . torsion . . . and spiral. Practical formulas for design, plus complete authoritative information on spring application, make "Mechanical Springs" a valuable addition to handbook and engineering data files. Mr. Wahl, an eminent authority on springs, and well-known for his development of the "Wahl Correction Factor," puts spring design on a rational basis.

You will find that no matter what your problem . . . working stress . . . fatigue . . . buckling . . . or just plain maximum efficiency, that the use of "Mechanical Springs" will reduce your number of spring failures due to "guess-work" as well as save you time and materials.

MECHANICAL SPRINGS

By

A. M. WAHL

Price* $6.00 Postpaid

SEND FOR YOUR COPY TODAY!

MD-4

THE PENTON PUBLISHING COMPANY

BOOK DEPARTMENT,

PENTON BUILDING, CLEVELAND 13, OHIO

Send me a copy of "Mechanical Springs" by A. M. Wahl

☐ On Ten days trial for free examination, following which I will either pay for the book at $6.00 plus postage, or return it in good condition.

☐ C. O. D.

☐ Remittance enclosed* in which case the book will be sent postpaid.

SIGNED: TITLE:

COMPANY:

ADDRESS:

CITY: ZONE: STATE:

* Orders for delivery in Ohio must be accompanied by an additional 18c to cover compulsory state sales tax.

ADVERTISING INDEX

A

Abart Gear & Machine Co. 244
Acme Industrial Co. 243
Allegheny Ludlum Steel Corp. 247
Allen Manufacturing Co. 190
Alliance Manufacturing Co. 230
Allis-Chalmers . . Inside Front Cover, 56, 57, 244
Allis-Chalmers, Tractor Division 244
Aluminum Company of America 47, 215
American Brass Company, The 53, 54
American Brass Company, The, American Metal Hose Branch 189
American Felt Company 177
American Metal Hose Branch, The American Brass Company 189
American Screw Co. 250
Amgears, Inc. 194
Arma Corporation, Subsidiary of American Bosch Corp. 223
Armstrong Cork Co. 147
Atlantic Metal Hose Co., Inc. 222
Automatic Electric Sales Corp. 60
Automatic Steel Products, Inc., Mercury Clutch Division 240

B

Baldwin Locomotive Works, The 200
Bellows Co., The 174
Beryllium Corp., The 180
Bethlehem Steel Co. 221
Blackhawk Mfg. Co. 22, 23
Bodine Electric Company 1
Briggs & Stratton Corp. 176
Brown & Sharpe Mfg. Co. 61
Browning Manufacturing Co. 239
Bruning, Charles, Co., Inc. 29
Bundy Tubing Co. 198
Bunting Brass & Bronze Co., The 11

C

Cambridge Wire Cloth Co. 160
Carpenter Steel Co., The 50
Cash, A. W., Valve Manufacturing Corp. . 220
Century Electric Co. 195
Chain Belt Co. 14, 15
Chapman Valve Manufacturing Co., The . 199
Chicago Metal Hose Corp. 235
Chicago Rawhide Manufacturing Co. ...2, 4
Cincinnati Gear Co., The 224
Commercial Shearing & Stamping Co., The 236
Continental-Diamond Fibre Company ... 161
Continental Motors Corp. 220
Cramer, R. W., Company, Inc., The 162
Crane Co. 26
Crocker-Wheeler Electric Manufacturing Co. 25
Crucible Steel Company of America 203
Cuno Engineering Corp. 41
Cutler-Hammer, Inc. .....Back Cover

D

Dayton Rubber Co. 40
Diamond Chain Company, Inc. 209
De Laval Steam Turbine Co. 224, 236
Delco Products Division of General Motors Corp. 169
Dodge Manufacturing Corp. 219
Dow Corning Corp. 184
Drop Forging Association 49
duPont de Nemours, E. I., & Co., Inc. ... 48
Dynamatic Division, Eaton Manufacturing Co. 70

E

Eastman Kodak Company 157, 185
Eaton Manufacturing Co., Dynamatic Division 70
Eclipse Machine Division of Bendix Aviation Corp. 237
Elastic Stop Nut Corp. of America 173
Electrical Engineering & Manufacturing Corp. 20
Electric Auto-Lite Company, The 72
Electric Motor Corp. 237
Electrol, Inc. 182
Euclid Electric & Mfg. Co., The 172
Euclid Universal Machine, Inc. 245
Ex-Cell-O Corp. 167

F

Fafnir Bearing Company, The 193
Farval Corp., The 55
Fawick Airflex Co., Inc. 187
Federal-Mogul Corp. 52
Fellows Gear Shaper Co., The 33
Foote Bros. Gear and Machine Corp. 39

G

Garlock Packing Company, The 208
Gates Rubber Co., The 231
Gear Specialties 19
General Electric Co. ...30, 31, 196, 212, 232
General American Transportation Corp. . 183
Gisholt Machine Co. 21
Globe Steel Tubes Co. 206
Graf, V. L., Co. 34
Gray Iron Founders' Society, Inc. 233

H

Hanna Engineering Works 163
Hannifin Corp. 166, 240
Hoover Ball and Bearing Co. 178
Houghton, E. F., & Co. 10
Hyatt Bearings Division, General Motors Corp. 217
Hydraulic Equipment Co. 218

I

Imperial Pencil Tracing Cloth Co. 226
Indiana Gear Works 232
International Nickel Company, Inc., The . 213

Nobody throws away Stainless Steel

Stainless steel *lasts*. Allegheny Metal stays bright and strong —gives lifetime service—under conditions of corrosion, heat and wear that send lesser metals to the junk-pile in a few years, or perhaps only months. Wherever a superior metal will give you advantage, you'll find it cheapest in the long run to use Allegheny Metal, the time-tested stainless steel.

Complete technical and fabricating data—engineering help, too—yours for the asking.

ALLEGHENY LUDLUM STEEL CORPORATION

The Nation's Leading Producer of Stainless Steel in All Forms

Pittsburgh, Penna. . . . Offices in Principal Cities

Allegheny Metal is stocked by all Jos. T. Ryerson & Son, Inc., Warehouses

ADVERTISING INDEX

J

Jenkins Bros. 42
Johnson Bronze Co. 145
Johnson, Carlyle, Machine Co., The 165
Jones & Laughlin Steel Corporation 151
Jones, Howard B., Division, Cinch Manufacturing Corp. 240

K

Kinney Manufacturing Co. 224
Kux Machine Co. 228

L

Laminated Shim Co., Inc., An-cor-lox Division 194
Landis & Gyr, Inc. 232
Linear, Inc. 220
Link-Belt Company 5
Logansport Machine Co., Inc. 168
Lord Manufacturing Co. 242

Mc

McGill Manufacturing Co., Inc. 249

M

Mahon, R. C., Company, The 38
Master Electric Company, The ..... Inside Back Cover
Mechanics Universal Joint Division, Borg-Warner Corp. 230
Meehanite Metal Corp. 66
Mercury Clutch Division, Automatic Steel Products, Inc. 240
Moccasin Bushing Co. 236
Morse Chain Company 64

N

National Bearing Division, American Brake Shoe Co. 27
National Forge and Ordnance Co. 63
National Motor Bearing Co., Inc. 201
National Vulcanized Fibre Co. 164
New Departure, Division of General Motors Corp. 6
Norma-Hofmann Bearings Corp. 229

O

Ohio Seamless Tube Company, The 179
Oilgear Company, The 9
Ozalid, Division of General Aniline & Film Corp. 32

P

Packard Electric Division, General Motors Corp. 37
Parker-Kalon Corp. 214
Pesco Products Division, Borg-Warner Corp. 207
Plastic and Rubber Products, Inc. 67

R

Raybestos-Manhattan, Inc., Equipment Sales Division 197
R-B-M Division, Essex Wire Corp. 242
Redmond Company, Inc. 12
Republic Steel Corp. 227
Revere Copper & Brass, Inc. 204
Reynolds Metals Co., Aluminum Division . 28
Rhoads, J. E., & Sons 226
Richardson Co., The 225
Robbins & Myers, Inc. 62
Rockford Clutch Division, Borg-Warner Corp. 222
Rotary Seal Company, The 155
Ruthman Machinery Co., The 242
Rynel Corporation 196

S

Scintilla Magneto Division of Bendix Aviation Corp. 43
Scruggs, Loyd, Co., The 243
Sealol Corp. 239
Shakeproof, Inc. 13
SKF Industries, Inc. 205
Smith, A. O., Corp. 211
Smith, Winfield H., Corp. 188
Speer Carbon Company 46
Spencer Thermostat Division of Metals & Controls Corp. 24
Standard Locknut & Lockwasher, Inc. ... 243
Standard Pressed Steel Co. 216, 230
Stephens-Adamson Manufacturing Co. .. 186
Strom Steel Ball Co. 222
Superior Steel Corp. 71
Synthane Corporation 35, 36

T

Telechron, Inc. 58
Timken Roller Bearing Company, The ... 51
Titeflex, Inc. 184
Torrington Co., The 202
Tourek, J. J., Manufacturing Co. 237
Townsend Company 159
Twin Disc Clutch Company 149
Tyer Rubber Company 192

U

United-Carr Fastener Corp. 228
United States Graphite Co., The ..44, 45, 181

V

Valley Electric Corp. 226
Valvair Corp. 239
Veeder-Root, Inc. 16
Vickers, Inc. 65
Viking Pump Co. 228

W

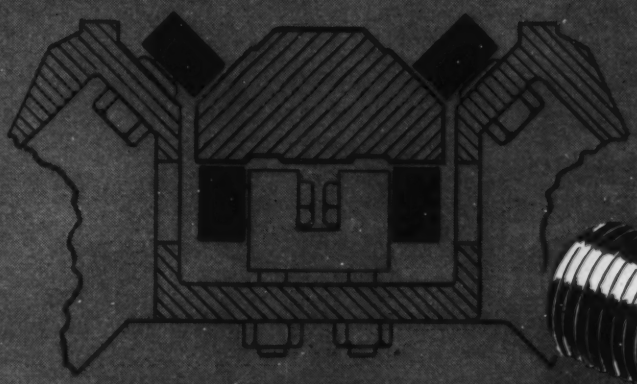
Waldes Kohinoor, Inc. 59
Ward Leonard Electric Company ...170, 171
Western Felt Works 8
Westinghouse Electric Corp. 175, 191
Whitney Chain & Mfg. Co., Division of Whitney-Hanson Industries, Inc. 69
Wisconsin Motor Corp. 239

Z

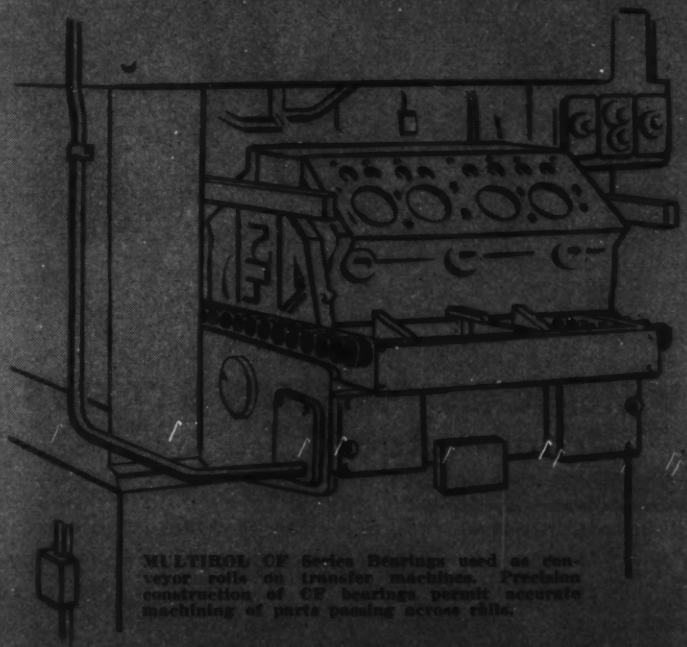
Zenith Carburetor Division of Bendix Aviation Corp. 210

Engineers Available or Wanted 244

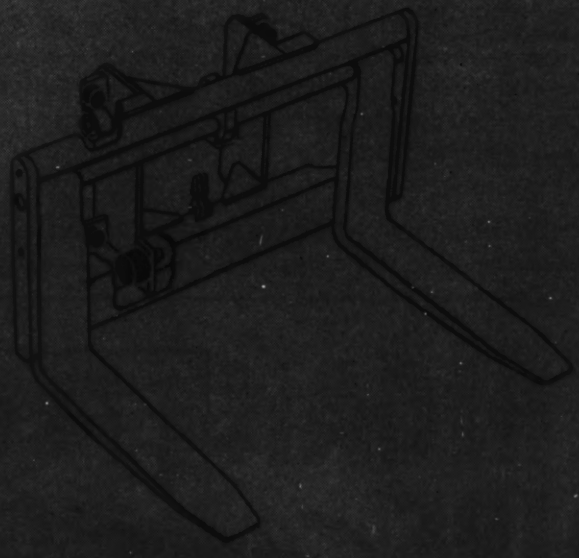
Increase Machine Efficiency



MULTIROL CF Series Bearings as support rollers for oscillating heads and tables on machine tools. Saves costly grinding and scraping of ways.



MULTIROL CF Series Bearings used as conveyor rolls on transfer machines. Precision construction of CF bearings permit accurate machining of parts passing across rolls.

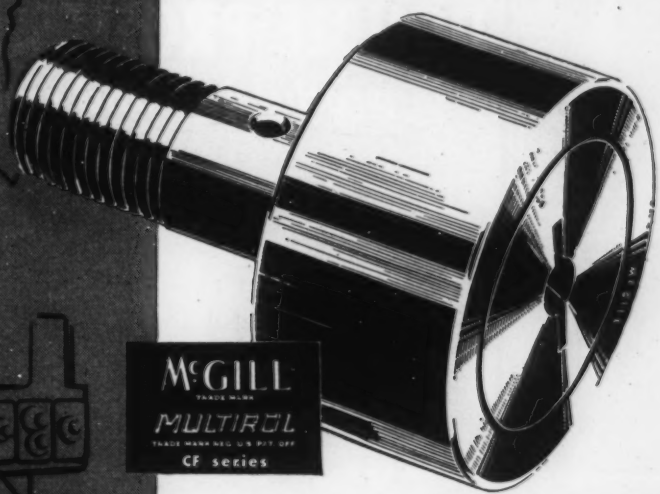


MULTIROL CF Series Bearings as mast and platform guide rollers on lift trucks. Ensure lifting and side adjustment of heavier loaded

with . . .

ANTI-FRICTION PERFORMANCE

the *MULTIROL* way

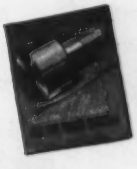


When your design goal is the ulumate in anti-friction performance . . . when your specifications include heavier static and shock load capacity . . . then MULTIROL Cam Follower (CF series) bearings are what you've been looking for.

The Cam Follower is a rugged bearing. An extra heavy outer race section stands the repeated shock of cam operation. A full complement of small diameter rollers make up an almost unbroken steel ring which distributes the load evenly over a greater bearing surface. Internal wear and friction are held to the minimum, and power requirements of MULTIROL bearing equipped machines are appreciably lessened. CF bearings are easily lubricated through the stud or face of the bearing and sufficient lubrication is retained for adequate protection of those neglected applications.

MULTIROL Cam Follower bearings are precision built in a range of twenty-two standard roller diameters from ⅜" to 4". This wide variety eliminates the need for special cam follower specifications in most machine design.

For dependable and long lasting anti-friction applications, at lower cost, investigate MULTIROL CF series bearings. Ask our engineers for their recommendations.



Write for Bulletin CF-40A. McGILL Manufacturing Company, Inc., 200 North Lafayette Street, Valparaiso, Indiana.

McGILL
TRADE MARK
precision bearings

Boat-builders launch DOUBLE PROFITS...
both in production and sales

. . . when AMERICAN PHILLIPS SCREWS "come aboard"

SMOOTH SAILING IN PRODUCTION: Boats almost build themselves . . . with the handling ease, driving speed, and non-slash protection of American Phillips Screws. Every fastening is clean and shipshape . . . *turned up flush, to stay.* And every American Phillips fastening *takes only half as long* as an old-fashioned slotted screw. So costs are really keelhauled!

SMOOTH SAILING IN SALES: From boats to bamboo bars, the American Phillips universal cross-recess enables manufacturers to put new decorative values, new sales appeal into their products. For American Phillips fastenings say "Modern Quality" so plainly that many manufacturers find it mighty good business to merchandise: "American Phillips Construction." How about *you?*

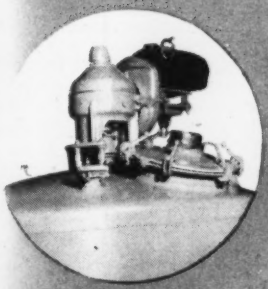
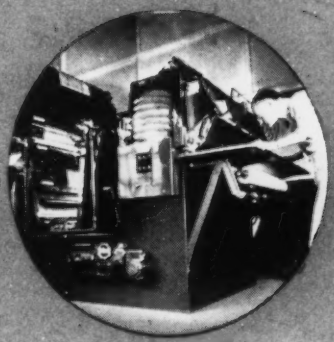
AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND

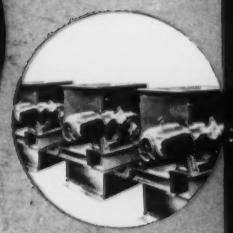
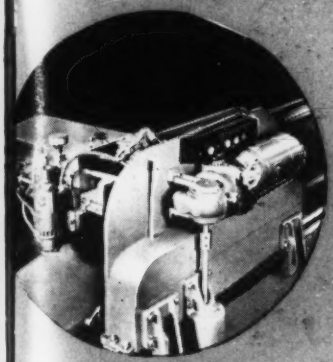
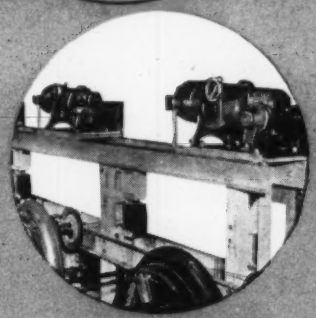
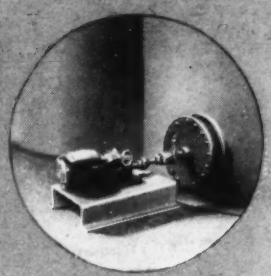
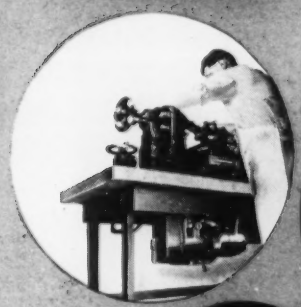
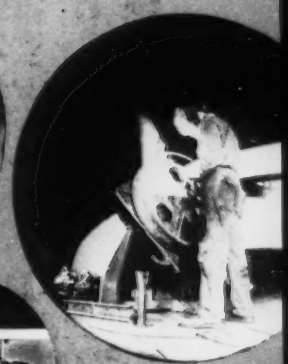
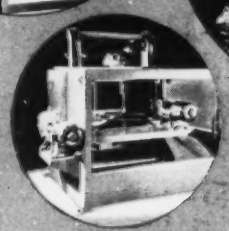
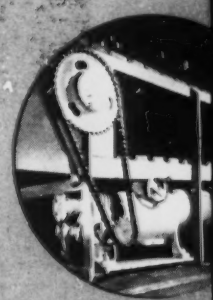
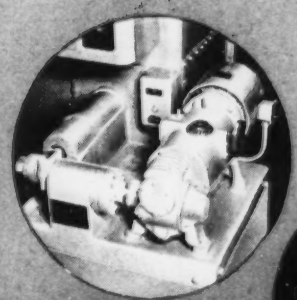
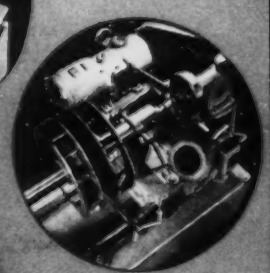
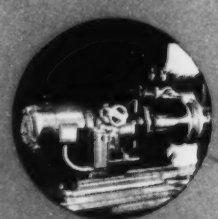
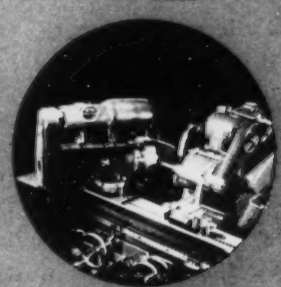
Chicago 11: 589 E. Illinois St. *Detroit 2:* 502 Stephenson Building

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

AMERICAN PHILLIPS *Screws*

ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

On thousands of applications, stepless variable speed operation assures exactly the right speed for every operation . . . for each operator . . . the right speeds for each change in the consistency or shape of the material being processed. Such variable speed operation pays off in higher rates of production, a better quality product and more efficient performance of your equipment and your operators.

variable speed operation doesn't cost

IT PAYS

Master Speedrangers provide this infinitely variable speed in compact, all-metal, mechanical variable speed units in a wide range of types and sizes up to 5 horsepower.

See how the Speedrangers on the applications shown incorporate an electric motor, a variable speed unit, a gear reduction, and an electric brake . . . all standard Master units that easily combine into a compact, integral power drive. This provides exactly the right speed, the right features, in a unit that you can use right where you want it.

Write for Data 7525, a new 24-page book on Speedrangers, and see what a real job they can do for you.

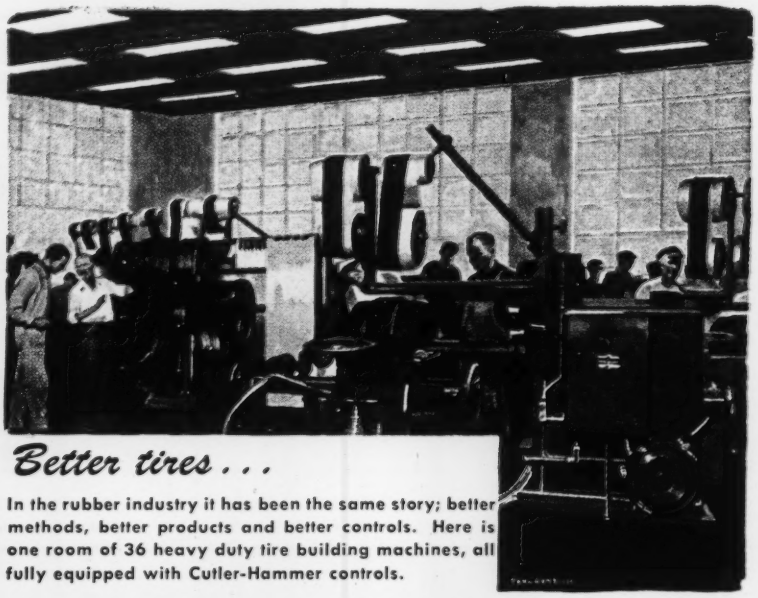
MASTER SPEEDRANGERS

THE MASTER ELECTRIC COMPANY · DAYTON 1, OHIO

Silent partner in progress

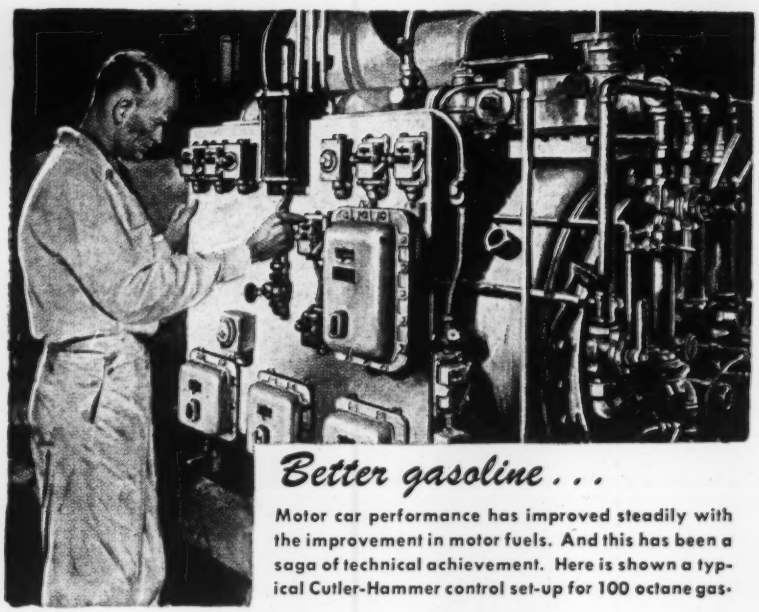
Better cars . . .

Cutler-Hammer engineers have worked continuously with automobile builders to effect production improvements and economies. Here is shown one of the earliest automatic welding control installations, a Cutler-Hammer "first".



Better tires . . .

In the rubber industry it has been the same story; better methods, better products and better controls. Here is one room of 36 heavy duty tire building machines, all fully equipped with Cutler-Hammer controls.



Better gasoline . . .

Motor car performance has improved steadily with the improvement in motor fuels. And this has been a saga of technical achievement. Here is shown a typical Cutler-Hammer control set-up for 100 octane gas.

Year after year America's factories stride ahead giving this nation things that amaze the entire world, spectacular new developments or vastly improved products within the reach of the many rather than the few. Such achievements are often the result of new processes or methods in which electric control equipment plays a vital role. It may be a matter of timing to less than 1/100th part of a second, the interlocking of numerous functions, the automatic regulation of speed, pressure, torque, or a dozen other variables. The list of such things control equipment is asked to do is almost endless. And yet it is often that in the proper doing of *these* things, yesterday's dreams become today's production miracles.

Cutler-Hammer general purpose motor control is recommended by a majority of all electric motor manufacturers, is featured as standard equipment by machinery builders, is carried in stock by recognized electrical wholesalers everywhere.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Cutler-Hammer Motor Control, quite naturally, is frequently involved in these epic achievements. For more than fifty years this product of highly specialized engineering experience has held the respect of the technical men in all industries. The experts insist on Cutler-Hammer Motor Control. Do you? CUTLER-HAMMER, Inc., 1310 St. Paul Avenue, Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.